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UNIVERSITY OF AGRICULTURAL SCIENCES
BANGALORE

PROCEEDING OF THE SEMINAR ON

RESEARCH MANAGEMENT

December 19-20, 1979

Dr. K. KRISHNAMURTHY
Director of Research

held at

COLLEGE OF AGRICULTURE
Dharwad

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FOREWORD

The Research System in the University of Agricultural Sciences is strategically the most important one. Not only in terms of the funds invested and the manpower employed in the system, but also in terms of knowledge created through research, this is true. It also happens that the research system has the access to the largest land, water and other production resources in the University.

It is desirable that in order to rise up to the expectation and reach the research goals set from time to time, the leaders engaged in research at different levels should have clear goals in view, and also conversant with the principles and practices of man management, money management, time management as well as programme management. As it happens, most of the research leaders do not have an opportunity of becoming familiar with the managerial philosophy, principles and techniques as it applies to research. Therefore, the Director of Research had created an opportunity in the form of a Research Seminar conducted at Dharwar on 19th and 20th, December 1979.

In various sessions an opportunity was provided in this Seminar to discuss the existing practices of management, the deficiencies as well as remedies, for the benefit of all. In the process, it was expected that all concerned

would recognise the scope not only for improving the research management but also learning some of the essential rules and procedures required to make the research system effective.

It is highly commendable that the colleagues of the Director of Research have taken the trouble to put together the papers and proceedings in a cogent manner and have brought out this publication.

The task of managing the research system is a complicated one. The Seminar conducted in 1979 is only one step in this direction. I earnestly hope that the Director of Research and his colleagues would provide periodically such opportunities to all those who are engaged in research to look at their own research responsibilities from the management viewpoint and bring about necessary improvements gradually.

March, 1981

R. DWARAKINATH
Vice-Chancellor

PREFACE

The first Seminar on Research Management was organised in order to bring together scientists in the various disciplines of Agricultural Sciences, in order to exchange ideas and experience, to adopt the concepts of administration and management in agricultural research.

The Seminar was attended by most of the senior scientists of the University of Agricultural Sciences and the discussions were detailed, thorough, and involving different policy matters that affect the research administration of the University of Agricultural Sciences. The recommendations that have emerged receive a careful consideration and implementation in order to improve the research management.

This seminar is first of its kind in this University and it is hoped that further Seminars will be able to take stock of the situation and lead to a periodical but sustained improvement in the research management component of the University of Agricultural Sciences.

It is a pleasure to express my grateful thanks to Dr. R. Dwarakinath, Vice-Chancellor for providing the dynamic leadership for the conduct of the Seminar. His constant encouragement and interest in the conduct of the

Seminar can be seen by the different recommendations that have come out during the discussions. I also thank Dr. S. V. Patil, Director of Instruction (P.G.S.) and Dr. R. B. Patil, Director of Instruction (Agri.), College of Agriculture, Dharwad, and their colleagues who spared no pains to see that this Seminar was a success. Indeed, it was a success. I also express my thanks to Professor B. V. Venkata Rao, who took the responsibility of editing and publication of this document.

March, 1981

K. KRISHNAMURTHY
Director of Research

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Highlights and Shortcomings in Agricultural Research

S. V. Patil*

The University of Agricultural Sciences, started in 1965 is vested with three main functions—teaching, research and extension in Agricultural Sciences. All the research stations formerly with the Department of Agriculture were transferred to the University. Karnataka State has one of the most diversified cropping system in the country. The research set up in the University was therefore reorganized with organization of five Regional Research Stations and a number of Medium and Minor Research Stations. The Chief Scientific Officers were appointed for important subject matter areas and were located at Regional Research Stations. During the last few years a few more research stations have been started. There are at present 18 A type and 14 B type research stations. In each subject matter area Head of the Department has been designated to coordinate the research, teaching and extension. A large number of research projects financed by I.C.A.R. and other agencies are operating at the University. Research in the teaching campuses is carried out not only by teaching and research staff but also by the postgraduate students with the guidance of the Major Advisors.

Recently a closer integration between teaching, research and extension has been brought about by transferring the adminstrative control of the research staff located at the teaching campuses from C.S. to the Heads of Departments at the Campus. In Agriculture Science there are at present altogether 12 Departments.

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* Director of Instruction (PGS), Dharwad Campus.

Highlights of research

The research work is conducted in 12 main subject matter areas. The work carried out covers a very wide spectrum. Many of the research findings are incorporated in the package of practices recommended for different crops. However, based on the information obtained from the concerned Departments, only a few highlights are indicated below :

1. Soil Science : Pedogenetic studies on important soil series in Malaprabha and Ghataprabha project area indicated that $CaCO_3$ is high in soils situated lower in the landscape and increases with depth. Deep ploughing of black soil has increased the infiltration from 0 5 cm/hr to 1.7 cm/hr. Addition of potassium to black soil decreased the extent of swelling and dispersion thereby improving the infiltration. Application of thiobacillus culture with sulphur improved the infiltration. Dipping the roots of paddy seedlings in a slurry of soil with superphosphate improved the seedling growth.

Black soil adsorbed higher Zn than laterite and red soil. Maize, wheat and paddy showed response to Zn application. The absorption of Captan, Wet Ceresan and Bendate was maximum in black soil.

The application of lime, based on exchangeable aluminium was found to be satisfactory in highly acid soils. Studies on use of pulp mill effluent for irrigation indicated that the uptake of sodium by crops was increased. Studies on bio-gas production revealed that water hyacinth produced more methane than cowdung.

2. Agricultural Microbiology : Efficient strains of rhizobia were developed for cowpea, blackgram, greengram, groundnut and soyabean. Inoculation for forage legumes resulted in about 12 per cent higher yield. NB-21 grass grown in association with forage legumes produced about 25 per cent higher forage yield.

Fifteen different strains of mycorrhizae have been brought into pot culture. Guinea grass was found to be good for mass production of mycorrhizae. For the first time the occurrence of mycorrhizae in acquatic plants in tropics has been detected. Inoculation of mycorrhizae increased the plant growth and P, Zn and Mg uptake in cowpea and ragi and reduced the infection of root-knot nematodes.

A simple technique for rapid multiplication of *Azolla* by adding 1.0 to 1.5 per cent cowdung in water has been developed.

Microbiological analysis of Harihar Polyfibre effluent indicated the absence of actinomycetes but the presence of bacteria, yeasts and filamentous fungi.

3. **Agricultural Engineering:** Research is conducted in areas of Farm Machinery, Processing Engineering, Soil and Water Conservation Engineering, Farm Structures and Environmental Engineering.

Development of automatic seed-cum-fertilizer drill, ridger and furrow attachments to the seed-drill, coconut dehusker are in progress.

Studies are being conducted on modifications to grain thresher to improve threshing quality, development of low cost grain driers, storage structures and bins for small farmers. Studies have been taken up on lining material to reduce seepage from water channels in black soil, drip irrigation, run off and soil losses under different canopies, land development systems for rainfed cultivation, utility of small size farm ponds for water harvesting, position of drainage tile openings and different types of drainage fillers, evaluation of solar heaters and on energy consumption in crop production.

4. **Plant Breeding:** Release and extensive spread of improved varieties of ragi, paddy, cotton, groundnut, wheat, jowar, gram, safflower, are the impressive records of research in plant breeding. Evolution of Varalaxmi cotton hybrid has

revolutionised the cotton ultivation in the irrigated areas. A range of Indaf varieties of ragi suitable for diverse conditions has greatly contributed towards increase in ragi production.

Linkage relationships between several qualitative characters of rice and sorghum have been worked out.

In tobacco, NPN-190 is good both in quality and yield. DH-3-30 bunch type of groundnut is doing well both under rainfed as well as under irrigated conditions. The research work on the development of *kharif* and *rabi* jowar, maize hybrid sunflower, Napier-bajra hybrid grass, and breeding work on cowpea, *avare* and other pulses, chillies, winged bean, *hibiscus* (*pundi*), safflower is worthy of note.

5. Crop Physiology: Studies on physiological basis for drought, salt tolerance and productivity has been carried out. Application of potassium has induced drought tolerance in ragi and groundnut by increased accumulation of proline through increased arginine conversion.

Foliar application of etharel increased translocation of metabolites in groundnut. Foliar application of TIBA at 50 ppm at flowering increased test weight of paddy.

Reduced rate of NO_3 flux in dark or low light intensity reduced the nitrate reductase enzyme activity.

Studies on ragi and sunflower exhudates indicated the presence of more ammoniacal-N in ragi than in sunflower indicating more nitrate reductase enzyme activity in ragi.

The relationship between leaf vein frequency and CO_2 fixation was noticed in ragi varieties. Soaking seeds of sorghum, paddy and wheat in 1 per cent $CaCl_2$ or 5 ppm Kinetin induced better germination and vigorous crop growth under saline conditions.

6. Agronomy: Development of double cropping practice of cowpea and ragi in red soil and green and *rabi* jowar in black

soil and application of fertilizer by seed-cum-fertilizer drill are some of the significant contributions made towards increase in crop production in dry land areas.

Development of cultivation practices including measures to control red leaf has greatly helped to exploit the high yield potential of Varalaxmi cotton in irrigated areas. Improved agronomic practices such as narrow spacing, higher population and balanced dose of fertilizer application have now become regular practices with farmers in case of hybrid jowar, groundnut, wheat and paddy for getting higher yields.

Application of N in three splits and P_2O_5 in two splits has been found to be better in sandy loam soils for paddy. So also application of P_2O_5 in two splits has been found to be better for sugarcane. Collection and storage of runoff water in excavated farm ponds has helped in controlling soil erosion and increasing crop production in low rainfall areas.

Research work on growth analysis of crops, bamboo and citronella cultivation, mixed cropping in jowar, cotton and sugarcane and water requirements of crops, chemical control of weeds, farming systems for moisture conservation are worthy of note.

7. **Horticulture:** As a result of extensive survey of mango plantations 151 outstanding clones have been located. Nekkare variety has been chosen as source of uniform root stock material for grafting. About 900 stock plants have been grafted with selected scions and evaluation studies are in progress.

In Mandarin about 40 disease free and high yielding trees were selected. The seedlings of 26 selections of these have been planted for further studies. Clones from Chettalli, Kudambur and Bhoodevi estates are more vigorous.

The treatment of the last two buds of the spur with thiourea at 1.5 to 2 per cent has been found to be promising in tackling

the problem of bud burst after fore-pruning in Anab-e-shahi and Thompson seedless grapes.

Uneven ripening in Gulabi grapes can be overcome to a great extent with spraying the raw berries after 5 weeks of fruitset with 2 sprays of 250 ppm of ethrel at one week interval.

In sapota, planting of Kalipatti variety with Cricket Ball, a good pollinator has increased the fruitset leading to higher yield. A new nursery technique on propagation of guava has been evolved. It includes close planting with a spacing of 5′ × 5′ ; and cutting the main stem at one foot to encourage the growth of lateral shoots which can later be used for layering or grafting. Many varieties of vegetable crops have been tried and promising ones are identified *e.g*, Sel. 102–1 in red onion, Texas-E-yellow in white onion, Gc-195 in garden pea, Pusa Jwala and G4 in green chillies, Synthetic-1 and early Kanwari in cauliflower, Pusa Desi in radish, S–288 in vegetable cowpea.

8. Seed Technology : Research in Seed Technology has been recently started and the work is carried mostly by post-graduate students.

Storing ragi at 15 per cent moisture content was found to support aflatoxin production. The aflatoxin did not affect germination of ragi.

Studies on storage of soybean indicated UPSS–69 retained higher germineability at the end of 12 months storage compared to Hardee. With advance in storage period there was increase in the electrical conductivity of the seed leachate. Electrical conductivity of the seed leachate was inversely related to germineability. Studies on drying of hybrid sorghum seed at 60°C with initial seed moisture of 25 per cent and depth of seed bed from 5 to 10 cm, indicated that germination of seed was not affected.

The planting ratio of 2 : 4 of pollen to seed parent gave higher seed yield of hybrid jowar CSH-8R per unit area.

Maximum per cent seed-set was obtained by pollinating on fifth day of stigma emergence. Higher seed yield was obtained when male parent was sown 20 and 10 days later than the female parent in summer and winter respectively under round about Bangalore conditions.

Cotton seed soaking in IAA (50 ppm), G.A. (50 ppm), succinic acid (0.01 per cent) or Kinetin (10 ppm) increased the seedling vigour.

Better quality and higher quantity of Varalaxmi Hybrid seed (20q/ha) was obtained with the application of 160–80–80 N, P_2O_5 and K_2O in kg/ha to the female parent, with 50 per cent of N, P_2O_5 and K_2O at sowing, 25 per cent N, P_2O and 50 per cent K_2O at 45 days after sowing and 25 per cent of N and P_2O_5 in five foliar sprays with 10 ppm NAA.

9. **Agricultural Entomology:** The Department has earned a good recognition for its work on Acarology and white grubs. over 40 species of mites, new to science have been described. The role of house-dust mites in causing human bronchial ashtama has been established.

Application of systemic insecticide through stem injection in coconut developed for the first time in India has shown a good promise for pest control in coconut.

An integrated method of white grub control has been developed. Research work on integrated control of boll worm using the parasite as one of the components of management practice has reached an advance stage.

The work on host plant resistance, and crop loss assessment due to pests has yielded valuable information. The research on chemosterilants has resulted in recognition of few chemosteriliants as effective in inducing sterility in some of the vegetable and store pests.

Some aspects of pathology and ecology of pebrine and muscardine disease in silkworms has been worked out.

10. Plant Pathology : Two new virulent races, 117 A–1 and 77B of wheat stem rust and leaf rust respectively has been worked out. Acid lime seedlings pre-immunized by two mild strains of tristeza virus has given good resistance to severe strains.

In addition to Tikka disease, rust and bud blight are found to be serious on summer crop of groundnut. Three sprays of Baycor (0.05 per cent) and Dithane M-45 (0.2 per cent) has given good control.

Radomil seed treatment at 4 g/kg followed by spray on 40th day of sowing has given about 100 per cent control of downy mildew of sorghum.

Tomato varieties Sioux—1 and NTDR were found to be comparatively resistant to both species of root-knot nematode.

Four chillie viruses have been identified and the work on estimation of losses caused by these viruses under field conditions is in progress. The survey on occurrence of spike disease of sandle in the forest area of the State indicated only about 5 per cent of the plants are affected. The disease could be transmitted to the seedling by grafting.

Dithane M–45 was found to be effective in the control of alternaria leaf spot of sunflower, blast of ragi and Ganoderme coconut.

11. Agricultural Economics : Block plans for full employment in Arkalgud, Basavakalyan, Bhalki, Badami and Muddebihal Taluks have been prepared. Detailed studies have been made on the cost of cultivation of the important crops grown in the State.

Studies have been carried out on pattern of fertilizer consumption in Karnataka, Techno-Economic survey of rice mills, income and employment effects of new technology, economics of maintaining tractors, changes in farming in Shimoga district, problems of agriculture credit, Identification

of constraints in the development of villages, and analysis of return to investment in certain crop and live-stock enterprises.

12. Agril. Extension: In this Department the research work has been carried out primarily through postgraduate students. The department has prepared inventory of resources of Tumkur district for integrated rural development. Studies have been made on constraints and factors permitting the adoption of agricultural technology among farmers, on evolving effective media mix for extension meeting to promote new technology among farmers and on identifying appropriate technology for small farmers.

A study on adoption behaviour of Varalaxmi cotton cultivation revealed that most of the recommended practices were adopted by majority of the farmers.

Studies indicated that there was significant impact of Television on Hungund farmers' knowledge. The level of knowledge gained was positively associated with their levels of education, but not with their age and land holding status.

Short comings

The University has an impressive record of research. A wide range of crops and a large number of disciplines are involved in the research. Again because of large number of qualified staff and postgraduate students involved in research during thelast about 10 years, a good base has been built up for high degree accomplishments. Although one could be rightly proud of the achievements one should not be complacent, but look forward for organizing and developing research programme in a better way for better results. The question we have to ask is—Are we getting adequate returns from our investments? Are we utilising the talents of our staff and postgraduate students in the best possible manner? Some of the shortcomings and a few suggestions for improvement are discussed below in brief:

1. **The research has to have a greater relevance to the needs of agricultural development.**

   (*a*) *There has to be closer integration between research, teaching and extension at the individual level.*

Teaching may greatly help to up to-date one's own knowledge. Ability to think lucidly, cogently and objectively and develop capacity – to grapple and solve the problems comes to a great extent as a result of specialisation and contact with postgraduate students. Involving oneself with extension of one's research findings in the initial stage may greatly help to get feed back information to further improve the achivements. Research, teaching and extension have an interacting effect when practiced together, and promote relevance, commitment and expediency. The staff in the teaching campuses are involved in teaching, and some of them in a limited way. Their involvement particularly at postgraduate level could be improved for mutual benefit. The staff working in non-teaching campuses can be involved in the following ways ;

(i) *Organising for teaching in agriculture subjects at other research stations at PUC level and in some stations for first one year or two years of the degree programme.*

Certificate or Diploma could be awarded at the end of two years of degree programme and the students who have shown good performance could be admitted for the remaining two years of the degree programme at the main campuses. A sort of Community Colleges could be started at the outlying research stations.

(ii) *Arranging for offerring of correspondence courses by the staff stationed at outlying stations.*

Correspondence courses in specialised areas separately for nongraduates and graduates could be organised by the staff at the research stations. Courses on sugarcane cultivation, cardamom cultivation, land reclamation, etc. could be organised.

This may greatly help to build a good rapport with literate farmers and extension workers.

(iii) *Transfer of staff from research stations to teaching campuses and vice-versa after a period of time.*

(b) **Greater involvement of staff in village adoption and Lab-to-land programmes, Krishi Melas and other extension type activities:** The programme which provides opportunities to the staff to visit villages, meet farmers, participate in training programmes may greatly help to get deeper insight into the problems of farmers. Research workers should actively participate in Krishi Mela. Some special demonstrations need to be laid out for discussing with the farmers the research findings.

2. **Greater scope has to be provided for the individual initiative:** As individual teacher is responsible for teaching and evaluation so also the research worker has to take the individual responsibility for research work. This means that every research worker has to prepare his own project, carry out the work, finalise the findings, wherever possible test them under farmer's conditions in collaboration with extension staff, get feed back information and further work to improve. He has to own resposibility for any good or poor performance. He may 'collaborate' with others, but not 'carry out' for others.

3. **Providing greater opportunity for self improvement:** The following are some of the measures suggested:

(a) Development of Libraries in the Department and research stations. Copies of the text books and reference books very often required could be kept in the Department library. Seminar notes, copies of theses, reports, reprints of the papers etc. could all be kept suitably classified. For building of the Departmental libraries more than finance, considerable efforts from the staff members is required.

(b) Provision of a separate room for each staff member. This will provide favourable environment for quiet study and work.

(c) Granting of six months to one year sabbatical leave for the staff after a few years of service with provision to pay part of to and fro travel expences to visit and work at other Universities and Institutions in India or abroad.

(d) Recognition of the good work done by giving one or two advance increments. Publication of books, bulletins, Lab. manuals, development of new instruments and techniques also should be suitably recognised. In addition to release of varieties, suitable practices developed should also be recognized.

4. **There should be one line of control :** Both administrative and technical control should be vested in one person, to avoid friction and conflict of interests at functional level. This may mean that at the regional research station level, the head for each discipline has to be provided/designated. In that case research station staff doing mostly Agronomic work have to be primarily responsible to Agronomist at the regional level. So also staff doing mostly plant breeding wark be responsible to the Plant Breeder at the regional level. At a bigger research station, a person of higher cadre could be in charge.

5. **Decentralisation of the technical, financial and administrative work :** This is necessary for closure supervision and to avoid delays. This would also enable the staff to take more responsibility and be accountable for the performance.

The subject matter meetings for drawing technical programme or for problem identification etc., could be held at the regional level. Senior persons from other places could however be invited to participate. The technical report of the research work carried out could be prepared at the regional level even in in some cases at the research station level and regularly published.

Decentralisation of financial and administrative matters by providing/designating suitable staff vested with the necessary powers at the regional level may greatly help to avoid delays and to improve efficiency. A manual indicating the procedures,

powers and responsibilities need to be prepared for the guidance of the staff.

At the departmental level the typing and electrical assistance need to be provided.

6. **Working arrangements with Government Departments, and other Institutions and research organizations for carrying out certain type of research work :** For survey type of work, or research to be taken on extensive area or catchment area basis collaborative arrangements need to be developed with State Government Departments. For example, research work on soil conservation, land development and land drainage, could be taken where such works are carried out by the State Departments. For such purposes standing committee for each concerned State Department/organization needs to be organised for such collaboration and necessary funds and staff provided at both places.

The highlights of research of various departments are briefly mentioned. In this paper an attempt has been made to bring out for discussion only a few important and relevant points that may help in improving the quality, usefulness and quantum of research.

Highlights and Shortcomings of Research in Home Science

Meera Rao*

Eight Agricultural Universities in the country have established Home Science Colleges as constituent units. The objectives of starting these Home Science Colleges are :

1. to provide a programme of instruction and training directed towards fulfilling the needs of rural families,
2. to provide opportunities for research related to the changing needs of individuals and families with perticular reference to rural areas and
3. to build up postgraduate programmes for preparing competent professionals to function as teachers, research workers and extension workers.

The target group is the entire rural community but emphasis is laid on the rural women and children. Unlike an urban home which is mainly a consumption unit, the rural family is a production unit where augmenting the income and conserving the resources are done with active participation of women. In this context, the role of the rural woman is not restricted to the routine duties of domestic care, but enters all areas of rural life including agricultural production, village industry and other aspects. They are engaged in tasks like preservation and use of farm manure, maintenance of milch cattle, preparation and sale of milk products, storage of grains and various farming activities. Even if rural Home Science Colleges cannot render service directly to this target group, it has to orient its educational and

* Dr. (Miss) Meera Rao, Assoc. Prof. (Food and Nutrition), Home Science College, Dharwad-580 005.

research programmes towards it. Home Science Colleges alone may not be able to do this but a net work of extension agencies, schools, system of adult education and non-formal education run by various types of agencies will be needed for reaching the target group.

The Review Committee on Agricultural Universities suggested that educational programmes in Home Science should be drawn up for training candidates: (i) for research, specialized jobs in teaching, development and administration, (ii) for general competence in Home Science as in other areas of academic disciplines, (iii) for specialized training as high school teachers and extension workers, (iv) for special certificate and training courses for all grades of rural workers as well as for younger people unable to attend formal schools.

With some of these objectives in view, the Home Science College was started on Dharwad Campus in 1974. The undergraduate teaching programme received priority over everything else. The first step was to finalise course work, set up the laboratories for day-to-day practicals and increase library holdings. Along side of this, came ordering equipment for research, and preparations to start postgraduate programmes in Food and Nutrition and Child Development. In the beginning stages since time available for research, laboratory equipment and space as well as number of staff members were limited, the only type of research that could be done was survey. Therefore, some of the staff members worked on survey of rural families. Since each project was carried on single-handed, the number of households that could be covered was limited. They can serve as pilot studies to plan further research projects.

Highlights of Research in Home Science

In order to select problems for investigation, with a view to improve home and family life in the rural areas, a base line survey was conducted in the village Chandanamatti. The survey covered the following aspects:

a) Resources and amenities available in the village. Main sources of income – Occupation.

b) The basic social characteristics – caste, family, type and composition.

c) Housing – type of construction, space, materials used in building, furnishing and decorating.

d) Clothing – construction, washing methods and purchasing pattern.

e) Food habits – purchasing and preparation, adequacy of the diet. Foods given to vulnerable groups.

Based on the findings of the survey, research and extension work was planned.

1. **Case study of a malnourished child:** A child suffering from acute protein-energy dificiency was selected to demonstrate the efficacy of a home made weaning food. At the commencement of the study, the 18–month old, male subject showed all the clinical signs of kwashiorkor. Diet survey indicated the child received the same diet as adults only in smaller quantities, consisting of black tea, snacks and jowar rotti. Legumes and vegatables were given occasionally. The experimental diet consisted of a mixture of locally available cereals, pulses and oilseeds, roasted and ground into flour and was fed in a semiliquid form. Feeding was continued for four months. Anthropometric measurements were recorded periodically. At the end of four months, the clinical signs of kwashiorkor had disappeared and the child showed steady weight gain.

2. **Study of filling materials used in the hay–box:** Locally available insulating materials such as paddy husk, paddy hay, wheat hay, coconut fibre and silk cotton were tried. Partially cooked rice kept in the hay box was completely cooked by insulation thus conserving fuel. Silk cotton filling was most effective as an insulating material and paddy husk was the least effective·

3. **Effect of pounding and grinding on iron content of foods:** Selected foods prepared by pounding and grinding in rural and urban households were analysed for iron content by chemical assay. There was considerable increase in iron in all the recipes. Increase was related to acidity of the food and length of time of processing. Whether the iron added in this manner is biologically available is under investigation.

4. **Effect of different market and household methods of storage on ascorbic acid content of vegetables:** Storing vagetables in an inexpensive earthenware utencil (Janata Refrigerator) was found to be the best method to prevent vitamin closs. Under market conditions, highest retention of both ascorbic acid and moisture was noticed in vegetables kept under cover and sprinkled with water.

5. **Perception level of the beneficiaries of the integrated Child Welfare Scheme:** This study showed that beneficiaries with higher levels of education, occupation, economic status and caste had better perception of the ICDS programme.

6. **Comparison of cognitive and social development of rural and urban pre-school children:** Size of the family, education and occupation level of parents and age of the child showed positive correlation with both cognitive and social developments.

Studies in Progress

1. Composition and cooking quality of HYV of sorghum.
2. Retention of thiamin and riboflavin in foods cooked in hay-box.

Scope of Research in Home Science

Since recognition of Home Science as a discipline for degree programmes is comparatively recent, adequate knowledge in foods and nutrition, textiles and clothing, child development and home management under Indian conditions is not available. Hence, it is necessary to conduct basic as well as applied research. In a subject like nutrition, which draws upon other

areas of science such as–physiology, chemistry and biochemistry investigations are still under way to determine factors tha determine human nutritional requirements and the functions o nutrients at the physiological level. Norms and standards fo judging adequacy of nutrition relevant to the community are y to be formulated. New items are being added to the list o essential nutrients, changes being made from time to time in th recommended levels in diets, as specialized techniques an methods for assay become available.

Therefore, although the rural Home Science College has give prime importance to the rural family, research in bas nutrition should not be over-looked.

Home Science has to conform to the standards set traditional home science programme and retain its identi besides functioning as a discipline in the agricultural universi integrating into it the rural concept. Teachers, teachi materials and methods, practical experiences and the philosop of Home Science as a discipline that concerns itself with the to well-being of mankind–food, clothing, shelter and psychologic well-being, have been in existence long before the ICAR resolv to start Home Science colleges as part of the Agricultu Universities. However, the rural home science college has mo resources to draw upon from related disciplines and has t responsibility to orient its activities to the rural famil Research in the rural home science college can be of two typ (i) as a separate field or (ii) be a part of research in agricultu sciences. Examples where inter-disciplinary investigation possible, are—

Suggested research in foods and nutrition	Areas from which methodology is drawn	Areas where results find application
1	2	3
Nutritive value and cooking quality of food grains	Chemistry, Biochemistry Zoology, Microbiology	Agricultura Botany, Agronomy

1	2	3
Consumer acceptability of HYV	Extension, Economics, Sociology	Agricultural & Marketing Cooperation, Economics.
Keeping quality and nutritive value of food grains	Entomology, Biochemistry	Agricultural & Marketing Cooperation, Economics.
Nutritional status, nutritional deficiencies, dietary adequcy	Extension, Human physiology, Biochemistry	Planning production of food grains and agricultural products
Shelf of processed agricultural produce	Horticulture, Microbiology, Biochemistry	Horticulture

Similarly, other inter-disciplinary research projects can be worked out in textiles, for testing of wearing quality of fibres and fabrics, or home management for study of time and energy expenditure in using agricultural machinery.

Shortcomings of Research in Home Science and Suggestions for Overcoming them

1. Communication of procedures and policies for submission of research proposals needs to be improved. Screening should be done in a meeting with staff mambers before forwarding the proposals to eliminate errors at a preliminary stage. Follow-up action needs to be taken on the proposals that are submitted.

2. *Lack of staff for teaching and research:* This can be remedied to some extent by building up a postgraduate programme with a strong rural bias not only to undertake needbased

research of problems prevelant in the villages but also to ensure suitably trained staff members for the future. The first generation of staff members have, of necessity, been trained in the urban set-up or have even come from disciplines other than home science. This can be overcome only if the rural Home Science College develops postgraduate programmes in all the subjects. The vicious circle of lack of suitable personnel for research and teaching-inadequate facilities to start postgraduate programme-dependence on urban trained graduates, can be broken by aiming for self-sufficiency in qualified personnel. This can be done if a beginning is made with the resources available and by working out inter-disciplinary programmes with a rural bias. This will also reduce the cost for research personnel such as research assistants.

3. *Lack of time for teachers to do research:* Teaching duties in a department can be staggered in such a way, that at least occasionally one trimester is available for a teacher to devote to full-time research. It is necessary to take cognizance of individual capabilities and interests when planning the technical programme. Junior staff members should be encouraged to work on part of a larger project rather than have individual ones.

4. *Lack of clerical help:* Supporting staff needs to be allotted according to amount of work in a department. Where more registers have to be maintained for consumables, food ingredients, chemicals, glass-ware in addition to deadstock, clerical assistance is necessary.

5. Equipment in constant use for practicals and research go out of order frequently. Having it repaired through the SPO takes a long time. If an instrumention section, or a technician to repair instruments is available, it can save time. This can be a common resource for all laboratories on the campus.

6. When a person is deputed to attend workshops, conferences or scientific meetings it is not beneficial to the

college unless the knowledge is shared with other staff members. It is good to have a policy so that when a staff member is deputed by the University, a seminar is given if it is relevant to research in home science.

As no large scale research projects have been undertaken till now, managerial problem are yet to appear. The equipment and space available are adequate to carry out small scale projects and graduate student research. These are self-sufficient to some extent in that, they seek cooperation of other departments such as – Statistics and Biochemistry, as and when needed.

Highlights and Shortcomings of Research in Veterinary and Animal Sciences

Animal Science faculty with 11 disciplines to start with at the time of formation of the U.A.S., initiated post graduate programmes leading to Master's degree in two disciplines in 1965-66. Later in 1969-70, Ph.D. programme was started in these two disciplines of Veterinary Microbiology and Pathology and also M.V.Sc. programmes in Gynaecology and Obstetrics, Pharmacology, Anatomy and Physiology. In 1972-73, all the disciplines started the M.V.Sc. programme and one more discipline *viz.*, Poultry Science was formed. Ph.D. programme was started in Animal Sciences also in 1979-80. Coming into the folds of the U.A.S., with the tripartite functioning of teaching, research and extension and starting of the postgraduate programmes, gave a big fillip to the research activity by the Veterinary faculty. Earlier only two or three ad hoc research programmes as sponsored projects were pursued in the college.

The research programmes undertaken in the first five years were of an exploratory type, mainly with the intention of identifying the problems among livestock in the State. As a result of these studies, many disease problems were also identified and a systematic surveys in limited areas were done to know the extent of such problems among livestock and poultry. Following are some of the highlights of these findings :

1. Reproductive diseases among crossbred cattle were common affecting the reproductive efficiency of the animals resulting in more unproductive days and proving an economic burden to the farmer. Diseases like Brucellosis, vibriosis, leptospirosis listeriosis etc., were recognised as directly affecting the reproductive capacity of the animals. Devitalising diseases like Theileriasis, Foot and Mouth disease etc., were found to reduce the reproductive efficiency of the cows.

2. Diseases of exotic nature like tuberculosis, John's disease, frontal sinus epithelioma among cattle, Marek's disease, respiratory diseases among poultry were recognized to be undetermining the very economy of the farmer besides being threats to livestock developmental activities.

   Further indigenous diseases like rinderpest, Foot and Mouth disease, mastitis, enterotoxaemia, Ranikhet disease were found to cause far greater losses in the livestock and poultry as the exotic blood increased in them and their reproductive capacities were high.

3. The performance of the exotic and crossbred animals under local field conditions was evaluated in a limited way.

The second phase of the research programmes concentrated on in-depth studies on some of these problems which had been identified as important ones in livestock production programmes.

Specific research projects were taken up either under University programmes or where more funds were needed, as sponsored research projects. The following research programmes sponsored by different agencies have been undertaken by the faculty.

Programme	*Sponsoring agency*
Bovine paraplegia	... ICAR
Bovine lymphangitis	... ICAR
Vibriosis	... FAO/SIDA
Room temperature semen extender	.... ICAR
Bovine abortions	... ICAR/AICRP
Calf mortality	.... ICAR
Nasal Schistosomiasis	... ICAR
Anaplasmosis	... ICAR
Poultry for meat	.... ICAR-AICRP
Baffalo breeding project	... ICAR-AICRP
Marek's disease	

Rumen Microflora	...	ICAR
Rinderpest virus	...	ICAR –Collaboration with I.I.Sc.
Residue toxicity studies of insecticides and pesticides in animals	...	M/s Indofil Chemicals, M/s Valleys of India (P) Ltd.
House dust mite allergy	....	D.S.T.–collaboration with Dept. of Entomology and Bangalore Medical College.
Brucellosis	....	ICMR — Collaboration with St. John's Medical College
Leptospirosis	...	D.S.T.—(G.O.I.)

Some contributions that have resulted from the studies under these programmes are noteworthy. Broiler breeds with excellent and economic feed conversion traits have been developed. Of these UBRO 1 and 2 have already been released and have proved popular with the farmers all over the country. A new hybrid broiler has been developed weighing 1 kg with feed efficiency of 2.2 at 6 weeks of age. Good growth and feed efficiency with no ill effect on blood urea nitrogen when cattle were fed up to 14 per cent of cattle feed with neem cake feed instead of groundnut cake. Cost of feed from birth to 18 weeks of age was reduced to 50 per cent using calf starters instead of whole milk. Soya milk as milk replacer caused a saving of over 30 per cent in cost in raising crossbred calves.

Studies on thyroid gland activity in the Malnad gidda cattle has shown that their activity is less than normal and this could be corrected by feeding 1.5 mg of Pot. iodide per cattle per day for 30 days. From this study it is recommended that supplementation with mineral mixture containing high calcium and iodine content could be beneficial for the cattle in Malnad area.

Diagnostic antigens and tests evolved here have been widely applied all over. Vibrio antigen is being prepared here and supplied to all the Veterinary colleges and other institutions in the country as a diagnostic agent. Immunoperoxidase test in the diagnosis of rinderpest and Marek's disease has proved extremely useful. Antigen and the diagnostic test for anaplasmosis have been developed here. Antigens for field diagnosis of Leptospirosis are developed and would prove to be an import substitute.

A biological control by the use of guppy fish for the intermediate stage of nasal schistosomiasis has been evolved.

Other important research programmes conducted include studies on the suitability of coconut water as a plasma substitute for i/v injection, substitution of maize in poultry feed by hominy feeds and the evolution of a sheep strain found to be better than Bannur breed with regard to body weight.

Four full-fledged regional diagnostic laboratories have been established under the UAS/KDDC project at Bangalore, Hassan, Mysore and Tumkur to provide health coverage programme to Dairy farmers. They provide immediate spot diagnosis of the diseases encountered in the areas. The programme also comprises of diseases survillence and monitoring epidemiological data and calendar of preventive vaccination programme.

Shortcomings :

1. There is need for the establishment of a livestock farm in the University to take up research programmes in animal production. The Dairy Unit at Hebbal, the Buffalo Breeding Project at Dharwar and other livestock maintained in various farms provide only limited scope as they have separate functions to perform. Our University has developed research stations for individual crops and similarly there is need to develop livestock research stations for each species of animals like cattle, sheep, goats and pigs. As a first step the

establishment of at least a single Composite Livestock Farm will give a great fillip to carry out research programmes in Animal Sciences.

2. An experimental animal house has not been established in the Veterinary College. This is very essential to take up any research programme of animal health coverage. At present for the isolation of infected animals used in our research projects, the facilities at the Institute of Animal Health and Veterinary Biologicals are being sought for.

The experimental animals used in research projects by various departments are at present housed in the College compound wherever some space is available due to the absence of an experimental animal house.

3. The small animal house of the College requires to be expanded urgently to meet the requirements of the various departments.

4. Both for teaching and research, many of the departments procure the materials needed from the slaughter house. Similarly dogs are procured from the dog pound for experimental purposes. As this is a regular feature a transport vehicle solely for the use of the College, to visit slaughter house and the dog pound and to collect other research materials is required.

5. Maintenance and repairs of instruments and equipments available in the various departments are not satisfactory. A procedure to get them rectified immediately has to be evolved.

6. Sharing of instrumentation facilities available in the various departments has to be streamlined.

7. The research projects (ad hoc sponsored projects) should be able to function as soon as they are sanctioned. Hence filling up of vacancies in these projects should be hastened.

8. Faculty members incharge of the livestock farms encounter innumerable difficulties to procure the animal feed and other day-to-day requirements in time. A simplification of the procedure to ensure regular supply of the requirements of the farm has to be evolved. This will increase the efficiency of the farm and also permit the staff members to devote more of their time to research work.

9. Heads of sections may be authorised to indent directly chemicals, glassware etc. which are under rate contract to avoid unnecessary delay. These items need not be referred to the Store Purchase Committee.

10. Ours is the only Veterinary College in India which is not having a Department of Meat Science and Meat Technology. Due to this, both the teaching and research aspects in this field have suffered. The need for the creation of this section need not be emphasised.

11. A toxicology unit is found necessary. There is an increased demand for the examination of various kinds of material for investigating toxicity problems.

Highlights of Fisheries Research in the University of Agricultural Sciences and Shortcomings/Constraints in Research and Research Management

H. P. C. Shetty*

During its brief span of only 10 years, the College of Fisheries of the University of Agricultural Sciences has achieved several commendable research results on various aspects of Fishery Science, in spite of the fact that the facilities are rather inadequate in some of the departments. Some of the results have attracted wide attention and are ripe for the transfer of of technology.

The more important of the research highlights ard detailed below :

A. Aquaculture

1. **Research results** : i) Shortage of carp pituitary glands in certain areas like the coastal regions of Karnataka was posing a serious problem in the production of carp seed through the hyphophysation techniques. Investigations conducted at the College to overcome this constraint have enabled the successful breeding of fresh water major carps by using pituitary hormones from the marine catfish *Tachysurus* spp. for the first time in the world. This method has already been adopted by the State Department of Fisheries in their various fish farms.

ii) Different types of pelleted feed have been formulated and prepared using ingredients like rice bran, groundnut oil cake, tapioca flour, poultry droppings, aquatic plants, cabbage leaves, fish meal, silkworm pupae, etc. These formulated pelleted feeds have proved to be more effective and economical than the conventional feed of rice bran and oil cake.

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iii) Feeding experiments carried out on the Chinese grass carp have indicated that the fish grows better when fed with terrestrial plants (hybrid napier, para grass and kudzu) than with aquatic plants (*Hydrilla and Ceratophyllum*). This is of particular importance in areas where the aquatic plants, which are the normal food of the grass carp, are scarce.

iv) Detailed investigations on pond fertilisation have shown that poultry manure is the best among the commonly available organic manures, such as cattle dung, poultry manure, sheep manure and sewage sludge cake. The effectiveness of poultry manure can further be increased by using it in combination with N. P. K.

v) Of the 6 inter-generic hybrids produced in the College, only the hybrid between male catla and female rohu has been found to be promising. The studies so far conducted indicate that this can be advantageously used in composite fish culture, in place of rohu.

vi) The freshwater catfish *Clarias batrachus* was found to be a compatible species for culture, along with 3 Indian major carps and 3 exotic carps and it helped in increasing the total fish production by 6 to 9 per cent. The best result obtained in these studies was over 10 tonnes/ha/year.

A field trial carried out on composite fish culture using 6 species of carps in a private fish farmer's pond has suceeded in yielding a production of over 6,000 kg/ha/ year.

vii) Marine catfish pituitary extract was ampouled for the first time in Karnataka.

viii) Fish seed have been successfully reared in aerated cement tanks with a high rate of survival.

ix) Acceptance of fresh poultry droppings as feed by carp fingerlings has been established by the poultry-cum-fish rearing studies carried out at Bangalore.

x) The work carried on paddy-cum-fish culture at Bangalore has revealed that the paddy fields could be successfully utilised

as nursery and rearing areas for the seed of freshwater fishes. This is of particular significance in the context of an acute paucity of nursery and rearing areas in Karnataka, as in the rest of the country. Fish rearing in paddy fields has also resulted in increased yield of paddy by as much as 6–9 per cent.

xi) The freshwater pond snails *Lymnaea luteola* and *Indoplanorbis exustus* which infest fish ponds, have been successfully controlled by using 2 ppm copper sulphate, without affecting the stocked fishes and aquatic plants.

xii) It has been possible to grow the aquatic plants *Lemna* and *Hydrilla*, which from favourite food items of the grass carp, under controlled conditions in cement cisterns. They are found to grow better when the cisterns are manured with cowdung than when they were manured with inorganic fertilizers.

2. Transfer of technology: Almost all the above results can be transferred to extension and to the farming community.

3. Shortcomings in research: It has not been possible to carry out breeding, hybridisation and production experiments at the desired level of intensity due to paucity of fish ponds. It has not been possible so far to test in larger water bodies the encouraging results obtained from composite fish culture in smaller water bodies at the College. As an extension of the work carried out so far, the hybridisation and production programmes should have been carried out on a much bigger scale in order to obtain conclusive results. Further the work carried out so far relates only to freshwater aquaculture, while two other important areas of brackishwater culture and mariculture have so far been left untouched. This is again due to the lack of requisite facilities which, it is hoped, will be provided by the University at an early date.

An important aspect of aquaculture concerns feed formulation and nutritional studies. Even though some studies have been carried out in this regard, it is felt that more meaningful research can be carried out only by getting the concerned staff adequately trained under experts.

B. Fishery Biology

1. Research results: (i) Oyster culture, which is well established in several countries abroad, has only recently been initiated in India. In view of the availability of commercial varieties of oysters along the Karnataka coast, work was initiated to study their reproductive physiology and culture possibility. The work so far carried out has shown that marketable sized individuals of the oyster *Crassostrea madrasensis* can be grown in the estuary within a period of 7 to 8 months. Techniques for successful collection of spat from their natural habitat have been evolved. Lime coated tiles, automobile tyres and asbestos sheets have been found to be the most suitable spat collectors.

(ii) A survey of freshwater prawn resources of Dakshina Kannada District has been completed, which has indicated the existence of 11 cultivable species of *Macrobrachium*. The biology of one of the more important species, *M. equidens*, has been studied and its nursery ground located.

(iii) A survey of the freshwater fishery resource of Dakshina Kannada District has also been completed. 33 species belonging to 19 families have been recorded.

(iv) A quantitative and qualitative estimation of brackishwater fish seed resources of Dakshina Kannada has been carried out. This should prove very useful when brackishwater fish farming is taken up in the near furure. Considerable interest has been shown by the coastal people in taking up brackishwater fish farming.

(v) Survey of fish diseases occurring at several centres in the State has been carried out and the requisite control measures were indicated to the concerned personnel. About 6 strains of the bacteria, *Pseudomonas* infecting the freshwater catfish, *Clarias betrachus*, have been isolated and control measures for the same are being evolved.

C. Fish Processing Technology

1. Research results — Canned products: (i) Apart from preparing the usual canned fish products, a number of new

canned products have been developed in the College of Fisheries. Most of these are quite promising and can be profitably taken up by the industry for commercial production. Among these may be mentioned mackerel-in-curry, sardine-in-curry, mackerel fillets in oil canned clams and mussels in brine, oil and masala and canned fish sausage. In addition to the above, technique have been standardised also for canning such prime table fishes as seer, tuna etc.

Fish sausages

(i) The College of Fisheries is the only institution in the country manufacturing fish sausages. Initially, the Japanese type of fish sausage packed in synthetic casing and fortified with a preservative was only manufacured. However, due to a couple of constraint in preparing this type of sausage, the College of Fisheries developed another type of fish sausage in natural casing identical to the meat sausage. Such sausages could be kept for about a week at +2°C and about a month under frozen storage at −20°C. As a further development to this work, the canned sausage reported in the earlier section, was developed and thery by its shelf-life has been increased over a year.

Other paste products: i) The College has also developed a number of fish paste products, such as fish balls, fish cakes with vegetables, shrimps with fish paste, etc. These are required to be stored at −20°C.

PHD fish meat and products developed therefrom: By treating with acid or enzyme, the fish meat was partially hydrolysed and deodourised (PHD meat), which rendered its easy incorporation into any of the common Indian snacks. A large number of fish products have been successfully prepared out of PHD meat, like fish sevu, fish sandige (fish wafers), fish jam, fish chakkuli, fish sauce, fish diamond cuts, fish noodles, etc. The PHD meat can be preserved at room temperature with edible acetic acid or could be kept for a fairly long time in frozen condition without any spoilage.

Fish protein concentrate or partially hydrolysed and deoduorised fish flour: This is prepared by a simple new method without involving the usual solvent extraction method. Since no solvent is used, this has overcome the serious drawback of the earlier methods, namely the fear of carcinogenic effect from the solvent residue. This new product keeps in good condition for more than a year. Its protein content varies from 87 to 93 per cent. This powder can easily substitute for PHD meat in the prepartion of a number of fish paste products.

Frozen fish products: By the use of a combination of anti-oxidants and wrapping of the frozen blocks in polythelene pouches, it has been possible to extend the shelf life of the mackerel up to 12 months and that of the oil sardine up to 8 months. Against the normal shelf life of only 3 months for the ordinarily frozen seer fillets, it was possible to achieve a shelf life up to 10 months by treating the fillets with a combination of a mixture of the chemicals–sodium chloride, ascorbic acid, monosodium glutamate and sodium tripolyphosphate.

Studies carried out on the frozen storage of minced meat of croaker have shown that the minced meat denatures faster than the fillets or the whole fish. It is, therefore, advisable to freeze fishes such as croaker in whole condition or as fillets and not in minced meat form.

Investigations have also indicated that freshwater fish could easily be preserved in frozen condition over 6 to 12 months without any considerable quality change.

Cured fish products: A new method has been developed for smoke curing of oil sardine which yields a product of good colour, flavour and taste with a shelf-life of 8 weeks at room temperature.

A method has also been developed and standardised for preparing fish pickle from lean varieties of fish, such as the pink perch. The product has no fishy odour and has a shelf life of more than 6 months at room temperature.

Of considerable interest is the development, for the first time in the country, of "fish shavings" from trash fish, after salting and hot smoking. The product has a protein content of 50 to 60 per cent and keeps well for more than 6 months at ambient temperature.

Animal feeds: A simple process of converting trash fishes and fish offal into liquid fish or ensilage has been developed, wherein the enzymes already present in the fish are only made use of for autolysis. The product can be preserved by the addition of an acid for well over a year. This liquid fish was found to be an excellent pig feed, as confirmed by the nutritional studies conducted at Hebbal.

The work carried out at the College of Fisheries has indicated the possibility of obtaining high grade fish meal from fish offal.

The effect of nature of raw material on the quality and shelf-life of fish meal has also been studied.

As a result of experiments carried out in collaboration with FAO experts during October–November this year, chilled sea water preservation of small pelagic fishes, like sardines and mackerels, immediately after they were caught, was found to retain the fish in much better condition than when it was preserved only in ice or left as such on the deck of the boat as is being commonly done by the purse seiners in this region. Marketing trials carried out with the chilled sea water preserved fish at Crawford Market in Bombay fetched decidedly a higher price than the ice preserved fish.

2. **Transfer of technology:** Almost all the above products are ready for transfer of technology to extension and the industry.

D. Fishery Engineering

1. **Research results:** i. *Adapter for dingly can seamer:* An adapter for seaming quarter dingly cans has been successfully

developed for use with the imported oval can seamer. This has enabled the use of the same seaming machine for seaming both the oval cans and quarter dingly cans.

ii. *Meat picking machine* : Of considerable significance is the development of a drum type meat picking machine, which has come in as a handy import substitute. The machine which has a capacity of deboning about 300 kg of fish/hour, was fabricated at a cost of only Rs. 18,000/ Imported machines of similar capacity would cost well over a lakh of rupees.

iii. *Line hauler* : Another gadget developed at the College is the "line hauler", which can be fitted on board, the fishing vessels for hauling long lines. This makes a considerable improvement over the present tedious and time consuming method of manual hauling.

iv. *Continuous exhaust box:* A continuous exhaust box for exhausting cans by steam has been designed and its fabrication is nearly complete.

v. *Net hauler* : A net hauler has been developed for hauling gill nets on board the fishing vessel.

vi. *Brailing equipment* : An effective and speedy brailing equipment has been developed for use by the purse seiners to facilitate the quick transfer of fish from the net on to the deck of the boat.

vii. *Hand aperated stuffer* : This newly developed equipment can be used in the preparation of several fish products, such as fish sausage, fish spiral, fish sevu, etc. on a cottage industry basis.

2. Transfer of technology : All the above mentioned research results can be passed on to industry.

3. Shortcomings in research : The designing and fabrication of new equipments to serve as import substitutes require to be enlarged and intensified. In this, the College is handicapped

in not having a suitably equipped workshop. Further the exploratory fishing carried out by the department so far has not been comprehensive and conclusive on account of the lack of a properly equipped deep sea going fishing vessel. Another major drawback in this department is the lack of facilities for detailed research in craft technology and gear technology, for which, apart from facilities, higher training of the concerned staff is a prerequisite.

E. Fishery Hydrography

1. Research results: i) Studies carried out on the rate of sedimentation at fishing harbour sites at Mangalore, Malpe and Karwar have indicated Karwar to be the best, followed by Malpe and Mangalore.

ii) Studies carried out near Ullal have served to earmark areas of rip current which has been periodically taking a toll of human lives. The work of of the College has enabled the Government to put warning board at the site.

iii) Temperature, salinity and current pattern have been found to be the prime factors determining the success or failure of the coastal fisheries of Mangalore.

iv) The biology of fouling communities in the Mangalore area has been studied. The extent of fouling on plates of different nature, such as wood, fibre glass, asbestos, etc. has been studied. The use of antifouling paints has also given encouraging results.

v) Pollution monitoring work in respect of discharge of effluents by M/s Mangalore Chemicals and Fertilizers Ltd. into the Arabian Sea has been successfully carried out over the last several years. Bioassay studies carried out in this connection have indicated the tolerance limits of fish and fish food organisms to various toxic substances which are likely to be present in industrial effluents.

vi) Hydrobiological studies of Gurupur-Netravati estuary and Ramasamudra tank have been successfully completed.

2. **Transfer of Technology:** The information obtained from bioassay studies can be passed on to the concerned industries.

F. Microbiology

1. **Research results:** i) A new technique has been devised to preserve microbiological plate cultures like that of fungi *Actinomycetes* and bacteria, for which a patent has already been obtained. This should prove very useful for educational institutions.

ii) The work carried out by the College on the incidence of *Salmonella* contamination of shrimps revealed that the shrimps were getting contaminated from the frog legs processed in the same factory.

iii) Of the 16 bacterial cultures isolated with the use of Chitin yeast extract agar medium, in connection with the "Studies on bio-degradation of Chitin", 11 cultures have been found to be positive for chitinase activity.

iv) Investigations on the reported lowering pH of the cooling and make up water of Mangalore Chemicals and Fertilizers have established that oraganisms belonging to the genera *Nitrosomonas*, *Nitrobacter*, *Thiobacillus*, *Ferrobacillus* and other heterotrophic bacteria are responsible for reducing the pH. It has been possible to control the activties of these organisms to a great extent by the use of biocides, sodium pentachlorophenate and 'Quat 2-C'.

2. **Transfer of technology:** The technology of preserving microbiological plate culture is ripe for transfer. In fact a private entrepreneur has already applied for making up the technique for commercial production.

G. Biochemistry

1. **Research results:** i) The nature of raw material was found to influence the jelly strength of fish sausage prepared from it. Proline and Alanine were found to be very effective in

controlling the denaturation of frozen meat of croaker and pink perch, particularly when the meat is preserved in minced form.

ii) Biochemical changes in the muscle, gonad, liver and blood of the catfish, *Clarias batrachus* before and after spawning have been successfully studied.

H. Fishery Economics

1. Research results : i) Work carried out on the economics of mechanised and non-mechanised fishing boats has revealed that 32' long mechanised boats are more profitable than 30' or 36' boats and non-mechanised boats of length more than 25' only are earning profit.

ii) Studies on price spread have indicated that the cost of transportation and ice, forms the biggest component of price structure of fish. These studies have also indicated that the selling price of fish could be brought down by eliminating some of the intermediate links.

Shortcomings/constraints in Research Management

1. When Research Projects are placed before the Research Council for approval, a certain sum is indicated towards total expenditure for implementing the proposed project. As per the present procedure, the projects so put up before the Research Council are approved without any reference to the amount that is going to be sanctioned for implementing the same. The project leaders naturally assume that they would be getting the entire sum proposed since the project is approved by the Council. But the actual sanction comes only year-wise and quite often the amount so sanctioned during the course of the project period is much less than the amount originally proposed. More often than not, this puts the project work out of gear, and adversely affects its prompt implementation. It is, therefore, felt that the amount to be sanctioned should be dicided at

the time of approving the research project in the Research Council itself, so that research workers can properly plan their work.

2. Sanction of year-wise budget for the Research Projects should be communicated in the beginning of the financial year itself, so that the initiation of the project is not delayed.

3. Research Projects in certain areas are bound to be a little expensive, but such projects are usually not approved by the Research Council in view of the limited funds available for the purpose. In case it is not possible to involve any other funding agency for financing such projects, the University should come forward to finance the same if the project is really worthwhile.

4. Considerable difficulty is experienced at present by the Research Staff for going on tour in view of the difficulty in obtaining T.A. advances. Further, similar difficulty is also felt in meeting contingent expenditures. Since the T.A. advance bills of the Research Staff will have to be sent to Bangalore and it is not always possible to plan the work very much in advance, more often than not the advances are either not received in time or not received at all. This has often necessiated the postponement of tours, which naturally upsets the planned schedule. It is, therefore, felt necessary to place in each major campus, an Accounts Officer or at least an Accounts Assistant with sufficient funds at his disposal locally for meeting immediate expenditures. This will serve to increase the efficiency of implementation to a considerable extent.

5. The present system of restricting the imprest advances to only one at a time to each of the Heads of Departments serves to cripple the various activities, since in a

department there are a number of workers each operating independent projects, and one worker cannot wait for the advance taken by another in the Department to be accounted for before doing his own work. Therefore, the system should be one advance at a time for each individual and not to the Head of the Department. Further, even in the case of an individual, if the advances asked for, are for different purposes under different schemes, he should still be able to get more than one advance. The only thing to be ensured in this connection is the prompt adjustment of the advances drawn positively within a period of seven days.

6. As per the present procedure, University vehicles cannot be given for field work for single individuals and there should be a minimum of three people. While the intention behind this procedure is understandable, it is not quite practicable in that it is not always possible to combine the work of three individuals. Quite often, to satisfy the existing requirement, one or two more people are also taken in the jeeps eventhough they do not actually have sufficient work. While it is necessary to economise on transportation expenditure by combining the field trips of several workers, it must be left to the discretion of the Campus Head to send the vehicle even for one worker if the situation so warrants. Fisheries is essentially a field science, and the implementation of Research Projects requires the workers to go out to remote areas, which are quite often not connected by the public transportation system. The present transport facility at the Mangalore Campus is thoroughly inadequate to meet the requirements of research workers.

7. The existing system of centralised purchases also at times comes in the way of efficient functioning of a Research Project. To obviate this difficulty, it is

suggested that arrangements be made to make stores purchases directly at each campus. It is understood that a Stores Purchase Officer is already functioning at Dharwad. Similar arrangement may be made at Mangalore Campus also.

8. Apart from shortage of funds, some projects are handicapped for want of adequate physical facilities and equipments. In the case of the College of Fisheries, this is partiularly so in the Department of Fishery Engineering, Department of Aquaculture, By–products section of the Department of Fish Processing Technology and the Department of Fishery Hydrography. In the Fishery Engineering Department, there is an urgent need for a suitably equipped fishing-cum-research vessel, which could also be utilised by the Department of Fishery Hydrography. Another urgent requirement of the Fishery Engineering Department is a suitably equipped. Workshop for designing and fabricating new equipments. An extensive freshwater fish farm is the immediate requirement for effective work in Aquaculture. This department also requires a brakish-water fish farm and mariculture facilities. Unfortunately, we are still to be equipped adequately with these facilities.

9. The pace of research is often affected by not filling up vacant positions over long periods of time. This is particularly so when the teaching schedule in the concerned department is very heavy.

10. In departments which handle a number of Research Projects, it is desirable to provide some clerical assistance.

11. The present system of having to send projects to be funded by agencies outside the University to a Review Committee in Hebbal, causes undue delay in the

finalisation of the project proposals. It is therefore, suggested that each Campus may have its own Review Committee for finalising such Research Projects.

12. Non-availability of servicing and repair facilities in respect of sophisticated instruments has been a serious constraint.

13. In the field of Fishery Statistics and Economics, it is often difficult to gather accurate field data from fishermen and merchants who are mostly suspicious of getting involved in income tax or commercial tax difficulties. Therefore the field data gathered are necessarily inaccurate to some extent.

14. The absence so far of any Extension Staff in Fisheries has been a serious handicap in the transfer of technology. Eventhough some posts were created some years ago, they are yet to be filled up. The establishment of the proposed Extension Education Unit at Mangalore has also not yet come off.

15. In certain areas where facilities in India are lacking, it is highly essential to get the concerned staff trained abroad for planning and implementing effective research programmes. The new policy of the University wherein it is proposed to depute teachers for higher training is a welcome step in this direction.

Highlights of Research and Shortcomings in the Field of Basic Sciences and Humanities

Dr. R. Narayana*

Bio-Chemistry: The research projects under investigation are related to the nutritive quality of sorghum, finger millet and other minor millets, particularly on the protein quality and the antinutritional factors which affect the protein quality of cereal grains.

The storage proteins of grain sorghum have been characterized by solubility fractionation, acrylamide gel electrophoresis and by their amino acid composition. The digestibility of the endosperm protein and the sorghum protein concentrate have been studied. It has been established that the *in vitro* digestibility of the protein concentrates prepared from the high-protein highlysine varieties of sorghum is affected by the presence of factors that inhibit, the action of the proteolytic enzymes.

An acid protease from germinated sorghum has been isolated in a pure form and fully characterised. The specificity of the enzyme on protein substrates suggests that the endosperm proteins of the sorghum grain are good substrates for the enzyme. Using this enzyme to partially digest the sorghum protein concentrate, it should be possible to prepare pre-digested sorghum protein concentrate for incorporation into cereal food formulations.

The proteinase inhibitors of grain sorghum have been purified and their mode of interaction with proteolytic enzymes has been studied. Conditions have been worked out for the inactivation of the proteinase inhibitors by processing of the sorghum endosperm flour.

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The protein content and amino acid composition of a large number of genetic and hybrid varieties of ragi have been determined. From this investigation some varieties of ragi with high-lysine content have been identified.

The *in vitro* protein digestibility of finger millet protein in relation to the tannin content of the grain was studied. The high tannin ragi varieties were found to have low *in vitro* protein digestibility. Dehulling had the effect of removing most of the tannin from the grain with concomitant increase in the *in vitro* protein digestibility.

The proteinase inhibitors of ragi have been characterised. Ragi flour has several proteinase inhibitors which inhibit trypsin. These isoinhibitors are being prepared in a pure form to study their inhibition characteristics.

Botany : The department has taken up research programme both in basic and applied fields.

Floristic study of Raichur and its vicinity has furnished the knowledge of vegetation of arid/semi arid zone. Among the 289 plants collected some were found to be drought and salinity resistant. *Cressa cretica* L. a member of Convolvulaceae, in particular was found to exade 10 per cent of sodium chloride. This character of the plant may be exploited for reclamation of salt affected land. The Department of Pharmacy, Veterinary College, Hebbal has shown that the plant *Cressa cretica* is the best among the diurisis inducting plant materials. It is also found that the plant has no harmful effects on the grazing animals. Thus *Cressa cretica* may be extensively grown both for desalinising the soils and for its medicinal value.

Survey of medicinal plants of Karnataka : In order to explore the availability of the medicinal plants and also to collect information with regard to medicinal use from rural and tribal people, survey is being conducted in different parts of Karnataka. So far about 250 species of medicinal plants have been collected from 15 districts of

Karnataka. Most them have been planted at the Botanical Garden, GKVK.

Breeding work on cultivated *Solanum melongena* and a wild species of Solanum is in progress. They readily cross and F_1 is fertile. The F_1 showed the dominance of the character of wild species. In F_2 population too the characters of the wild species were dominant showing resistance to diseases without affecting the yield. Further work for selecting the suitable ones is in progress.

Histochemical studies in the reproductive phases of *Nicotiana tabacum* and *Capsicum annum* revealed that although the polysaccharides were not strictly observed in all tissues of the ovule in the form of starch, except in mature egg, and central cell of the embryo sac, PAS positive tinge prevailed in the cytoplasm throughout the ovule development. A conspicuous feature observed was the occurrence of thick PAS—positive wall around the megaspore mother cell which has a direct influence on meiosis. Egg cell stores starch indicating its autonomy.

Botanical garden: The Department has been collecting the tree species of plants of Karnataka and growing them in the Botanical garden of GKVK. Nearly about 500 species are assembled in the arboretum. The grass flora and arboretum flora have been published.

Microbiology

Mirobial toxins: The microbial toxins have been studied six from systems on different aspects. All the toxins studied were glycopeptides in nature and were non-specific but had major role in disease production. The information would help to the plant breeders to evolve a variety which may not have a binding site for such chemicals or it may be chemically neutralised. The toxic compounds were isolated from plants which were infected by obligate pathogens. This is the first report in the world in detail on the toxins from obligate parasites. It was a unique concept in the field of toxioclogy. Aflatoxins have been isolated

from ragi crop. It was always thought that aflatoxin was a storage grain problem. This work showed that the grains may contain aflatoxins prior to the harvest as the moulds propogate heavily on earheads especially during the moist spells of rainy seasons. The variation in pathogenesis of different isolates and mutants was due to the fact that the virulent strain produced a more potent toxin whereas the compound isolated from a less virulent strain was not potent enough to cause a severe disease symptoms. Hence it was showed that the synthesis of toxic compound by the pathogen determined the virulence. This will help in plant protection in long run.

Nitrogen fixation by microorganisms: Acid tolerant *Rhizobium* has been isolated from a local soil and its performances has already been studied on cowpea and further study is in progress. The phyllosphere microflora on some common plants of Karnataka has been studied and identified the nitrogen fixers among them and determined their significance. The chemotoxis of *Rhizobium* towards gram root exudate has been studied and reported. The slime production of the strains of *Rhizobium japonicum* was studied and related their properties to nitrogen fixation.

Bacterial cross protection: In this study, the effect of a virulent strains of *Pseudomonas solanacearum* on the virulent strains in pathogenesis the identification of isolates and standardisation of wilt index are in progress.

Antibiotics for controlling the bacterial wilt in tomato: Paushamycin proved to be a better antibiotic among the streptocycline tested against the growth of *Pseudomonas solanacearum* in the laboratory. The field study of these antibiotics is in progress. Green house study indicated that none of the antibiotics control the disease to the satisfaction.

Biology of Azolla: Azolla was grown in mini cement tanks and the population persistence and life cycle are in study. We detected *Azotobacter* on the leaf surface of Azolla, which

means non symbiotic nitrogen fixing bacteria are present on the Azolla. The study is in progress.

Zoology

1. Biology of Arthropod parasites of fishes on Karnataka: Parasitic infestations of copepods: *Lernea* sp., *Ergasilus* sp. and *Argulus* sp. and an Isopod *Alitropus* sp., on food fishes in the tanks of Karnataka were surveyed. Their parasitism causes potential damage to the growth of tank fishes. Most of these parasites release sex attractants into the medium which induce and determine the ecobehaviour of them.

Dr. Sundara Bai, working on these aspects, won the Jawaharlal Nehru Gold Medal of ICAR during 1979 for her research findings.

2. Litter degradation by earthworms in Bangalore soils: Bangalore soils are inhabited by 6 species of earthworms. They exhibit interspecific zonation in their vertical and subterranean movements and specifically choose to feed on certain types of leaf litter. Their anachoresis help transporting nutrient into different areas in their horizontal migrations in the soil layers. Their casting help humifying the soils and enrich the mineral and nutrient content available to the plant growth. Once species is found to enrich ionic calcium in soils by solubilizing the $CaCO_3$ and Ca-oxalates of consumed soils.

3. Millipedes and their role in agro-ecosystems: The biology of plant feeding millipedes of Karnataka were surveyed at Dharwad Campus. Some of them are a regular nuisance to crops, causing considerable damage to growing crop plants. Humidity seems to be the important factor for their survival and behaviour.

The millipede *Jonespeltis splendidus* feeds on decaying plant debris in soils and humify the soils at a faster rate through defaecation. Mango leaf matter is degraded more by the activities of these millipedes. Symbiotic fungi harbouring their intestines help degrading the leaf matter.

4. Efficacies and mode of action of single dose rodenticides: The cost-benefit ratios of single dose-rodenticide like vacor and silmurin were worked out. These two yielded more returns than the zinc phosphide. However, silmurin is not very economic as it imparts baitshyness in rats. Vacor, in field trials yielded 90-95 per cent results especially during *rabi* season. The physiological effects of these rodenticides when administered in sub-lethal doses, were surveyed. Vacor inhibits niacinamide metabolism and acetylcholine esterase activity and produced necrosis of tissues. Silmurin arrests the cardiac function and knocks down the appetite.

Chemistry

1. The investigation taken up to identify and determine the concentration of phytotoxic substances in the soils of agriculture stations, Hebbal and GKVK reveals the presence of benzoic acid, p-hydroxy-benzoic acid and dihydroxy-stearic acid. The concentrations of these acids are likely to affect the crop-growth. Balanced fertilizer application may therefore be deemed helpful to reduce the concentrations of phytotoxic substances in soil and promote both germination and growth of paddy and ragi.

2. Phosphazenes - synthesis and utilisation as ultra high capacity fertilizers: The performance of synthesised Hexaamino-cyclotriphosphazen (HACTP) N_3P_3 $(N.H_2)_6$ containing phosphorous was tested on Poorna ragi. Its performance is equivalent to that of superphosphate and urea with equivalent P and N content.

4. Boron status of soils and waters of RRS, Raichur and other minor and medium stations under RRS, Raichur: Analysis of water samples for boron and other chemical constituents reveals that content is within the safe limits.

Physics

1. Meteorology in the services of agriculture: The daily rainfall data recorded at different taluka stations in Bangalore,

Kolar, Tumkur, Chitradurga, Gulbarga, Bijapur, Dharwar and Bidar districts were analysed to find (a) the mean weekly rainfall (b) Coefficient of variation of weekly rainfall and (c) the probability of a particular week remaining as a dry week.

The water availability to the crops of different durations in different types of soils was investigated. The optimum sowing periods for crops of different durations in different stations were worked out. The probabilities of occurrence of optimum sowing rains was estimated. The frequencies of occurrence of rainy days with different amounts of rainfall, the frequencies of occurrence of dry and wet spells were computed.

2. **Systems analysis approach for crop planning of groundnut in Kolar and Bijapur Districts**: Groundnut is the most important oilseed crop grown under rainfed conditions. The investigation carried through the systems analysis showed that sowing in June is favourable for Bijapur District. In Kolar district it was found that sowing of groundnut during first fortnight of July results in low productivity.

3. **Effect of shadowing materials on the size of latex practices**: Different materials such as chromium, palladium, platinum and alloys such as platinum–iridium, chromium-palladium etc., were used for shadow casting the latex spheres and the variations in the dimensions of the shadowed latex spheres with reference to unshadowed latexes at different magnifications was investigated. The analysis showed that chromium causes a diminition whereas palladium slightly increases the diameter of latex. The alloys appear to be ideal which do not cause any alteration in the dimension of latex.

4. **Peristaltic motion in porous media**: The flow of a fluid through porous mediain channels with sinusoidally varying cross-section was studied. The flow is caused by prescribed pressure gradient and by the variation in cross-section that occurs during the passage of a prescribed sinusoidal peristaltic wave along the walls. Perturbation solutions are found for the stream function. The flux through the channel was also calculated.

5. The effect of magnetic field on seed germination and plant growth: The studies conducted so far using the physical parameters like the magnetic susceptibility, infrared spectra, x-ray diffraction, electroluminesence of the magnetically treated seeds showed that treating the seeds with a stationary magnetic field imparts energy to it. This extra energy imparted to the seeds before their germination results in the early germination and sturdy growth of the plant in its early stages.

Statistics—Research on applied aspects

(a) Application to Economics: In a study of similarities in crop-pattern, a new method based on the Pythagorean distance concept for measuring the similarities of the cropping pattern for Karnataka and India was adopted for the different 5 year plan period.

A project was taken up to study changes and trends in area, production and productivity of important crops for the Karnataka State. Both linear and compound growth rates were worked out for these crops. In addition, the trends in prices were also studied by working out the linear rate of index number of wholesale prices for some important crops. At present a detail study *viz.*, 'Temporal and Spatial analysis of price-arrivals of Jowar' has been taken up in P. G. Research programme.

Another related project on land—use pattern at the State and as well at the District level, was also conducted. A project in collaboration with IASRI, New Delhi on the utilisation of Land fallows and causes there for in the State is completed with respect to data collection. Report is under progress. Studies were also made on trends in area, production, productivity and cost of cultivation of sugarcane in Karnataka State. In order to compare the performance of each district in the agriculture front, agricultural efficiency indices based on certain criteria were worked out.

Projections of food requirements and availability were made, in 1968 for the period 1976-81 for Karnataka, following three

different methodologies. These studies revealed that projections made in 1968, borne out to be sufficiently accurate for 1976. In 1978, in a separate study food projections have been made following two different methodologies.

(b) **Application to meteorology:** Several mathematical approaches were made to understand the weather phenomena, specially the rainfall. A Marko—dependent geometric model and one using logarithmic services, were found to be good fits for wet spells but not for the dry spells. In other studies, probability of rainfall for monthly, fortnightly intervals were estimated. The probability estimates of weekly rainfall is also under study. By studying the rainfall attempts were made to identify the factors affecting the severity of drought and using these factors 'Drought' was defined. Other studies, in this respect include the crop-weather relationships.

(c) **Application to Agriculture:** Several studies have been made to find out the optimum plot size and shape for experimentation in important field crops. In this regard, an attempt was made to estimate the soil heterogeneity indices for different crops at different research stations, utilising the data from the experiments having incomplete block design. Besides, several uniformity trials have been conducted on crops like cotton, sunflower, cowpea etc., in detail and opt. Plot size and shape have been estimated. Also detail plans of optimum block size and shape, designs to be adopted have been studied for sunflower.

Several statistical techniques were used in evaluating yield differences. The analysis called for complex methods involving group of experiments ranging over space and time. Also, several experiments in cultivators fields called for special methods of data treatment, often inventing a new approach altogether. Further, for graded agronomic treatments, whenever feasible functional relationship were built up.

Veterinary and other fields

Models for egg production in white cornish hens: A mathematical model was found suitable in relating the quantity of egg production to the egg laying period (t).

In a project, to study on a parasitic diarrhoea complex among sheep and goat, a discriminant function analysis approach was found useful.

In another collaborative project, protein requirement for sexed broilers and the effect of mixing varying levels of tamarind seeds on body weight of white leg horn chicks, were studied.

Other projects studied were in collaboration with Home Science Department in evaluating tastes and opinions about several nutrient preparations.

In Social Science: In a collaborative study on 'Untouchability and social legislation', the role of legislation in erradicating the practice of untouchability was studied.

Mathematics

Research projects, wherein the results and findings arrived at, will be very useful to the farmers have been undertaken and successfully completed.

1. The department analysed the rainfall data of MRS, Hebbal for the seventy year period (1897 to 1966) and worked out the probabilities of getting selected levels of rainfall. Using the water table, suitable planting period for dry ragi was suggested. The analysis indicates that planting of dry ragi in July ensures the maximum chances of getting the required rainfall.

2. Also this study was extended and the fortnightly probabilities of getting selected levels of rainfall were calculated for the crop-growing season in Hebbal region.

3. Also, study of wet spells for Hebbal and Bijapur regions, using logarithmic series, was done and suitable tables presented.

4. The persistency of rainy days in the dry region of Karnataka was studied and the paper entitled by that name was presented at the second World Congress on Water Resources held at New Delhi.

5. The rainfall erosion index of Raichur was calculated and the E.I. value is found to be maximum in the month of July. Using rainfall intensities, the kinetic energy of storms having more than 10 mm rainfall were calculated and from this, E.I. values were obtained.

6. Two mathematical models, (i) for changes in the soil organic matter and (ii) pressure changes in Aorta were worked out using differential equations.

7. A few mathematical models pertaining to flow of fluids in MHD porous media were set up and successfully completed.

Sociology and Economics

1. *Research Areas:* The department has undertaken research in the areas of Sociology of adoption of innovation, rural youth and children, small farmers, labourers and other weaker sections, the rural elite and power structure, social legislation and local organisation and irrigation impact. The rural credit and the role of commercial banks in agricultural developments, technology and employment, block plans for development were some of the studies in the field of economics.

2. *General findings:* The various studies have revealed some significant results which in general indicate the rapidly changing phenomenon of rural society in Karnataka. The farmers have grown conscious of the needs of improving their economic standards by readily accepting the technology suited to their conditions. The rural youth has awakened and has shown signs of carving a role for himself gradually casting away his docile submissiveness to the social structure and accepting modernisation with an open mind so long it helped to improve his lot. The rural society has been gradually becoming

conscious of the problem of child and inadequate conditions for its development.

The small farmers and agricultural labourers are emerging as a new force in the rural social structure with their consciousness for self-realisation and reluctance to submit to the age old conditions of serfdom and oppression. Other weaker section like scheduled castes have found their new place in society and politics of village life with their assertions to shatter the age old socio-economic shackles, though conditions favouring their development are be set with negation and contradictions.

The rural power structure has been undergoing radical transformation in the sense the hitherto powerful segments of wealth and higher caste status are gradually yielding their place to the historically insignificant segments of lower class and castes who constitute numerically dominant groups that have their own place in democracy and contributing to the new class of elite.

The force of secularisation are afoot in rural society as revealed in the process of the gradual delinking of caste and religion in the matters of economy and politics, though very often the caste and religious sentiments are exploited by the vested interest for material gains. The new irrigation projects though contributing to the agricultural growth have given scope for the emergence of new class of affluent farmers which is alienating from the main stream of village life and treating agriculture as a capitalistic commercial proposition and thus negating the notion of growth with justice.

The role of commercial banks in agricultural credit has come to be a new phenomenon in rural society. This institutional structure, however inadequate, has brought in a new hope for the credit starved agricultural sector and the farmers have developed an attitude of business relationship with the banks. The new technologies being introduced in agricultural sector is required to be more labour intensive than capital

intensive. The concept and implementation of block plan or drought prone area programme seemed to be more feasible as a developmental strategy in the rural sector calling for an authentic appraisal of resource inventory, development-oriented leadership, committed administration and trained development agents.

Psychology

The finding in a series of studies conducted so for are :

1. 70 to 80 per cent of students in the new system are able to complete their degree programme within the minimum period.

2. It is easy to identify the low achievers in the beginning of their degree programme and hence the remedial measures could be taken up to improve the performance of such students.

3. The Pre-University perfomance was the best predictor variable of CGPA when compared to other significant variables such as intelligence test scores, study habits and study skills in merit or disadvantaged student groups. The performance of the scheduled caste and tribe in all the above academic and intellectual measures was significantly lower than the merit and backward class groups. The value pattern suggest that the merit group being intellectually oriented, no one desire to be the leaders but also like to exhibit certain qualities of leadership in taking decisions, doing things independently and to stick on to their own decisions. The Scheduled caste students desire that they should be considered as important and admired in what they do. They want to do things that will pay off and take care of them. The correlations of values with CGPA suggest that orderliness, goal orientation and behavolence are positively associated.

4. In a study of grading standards in the two campuses the results revealed that different grading standards exists for different subject areas and also among the courses in each subject area within the campus and also between campuses.

5. A study of the farmers who have voluntarily sought the guidance of the Directorate of Extension in the UAS indicates that farmers with large and small land holdings are making use of the services and guidance of the Extension wing. The largest number of queries is on cultivation and the least number on seed treatment and production.

6. A scale to measure the different perception of adopters and non-adopters is constructed. This scale is useful to identify the perceptual barriers among the non-adopters.

7. Scales were also constructed to measure attitude towards women and attitude towards narcotic drugs.

Shortcomings and Remedies

1. In the Faculty of Basic Sciences and Humanities only the minimum required teaching staff has been created with the result most of them are busy throughout in teaching and very little time is left for carrying out research. This is a handicap for a large volume of productive research. In order to overcome this it may be suggested that for each department two Research Assistants may be provided, who can be guided to work on long standing important problems as well as that come up occasionally.

2. Funding of research projects in BS & H has been a problem because the ICAR has not been encouraging long range research projects in BS & H except for a few ad-hoc schemes. Here again the recruitment of competent personnel for short periods is difficult because no competent scientist would like to take up short-term appointments. To utilise these positions/ fellowships for the research students is also not possible because in most of the departments there are no degree programmes of their own. When funding is requested from other agencies like Atomic Energy Commission, C.S.I.R., I.N.S.A., etc., not only there is discrimination but also the same handicap of temporary ad-hoc schemes with fellowships is faced.

3. The Research in Basic Sciences require sophisticated instruments and the minimal service facilities like continuous water supply, gas supply and fume cupboards with exhaust system etc. These minimal facilities are not available in the various departments. Even a Central Instruments Centre of pool is not available in the University headquarters. Similarly there is no workshop facility for fabricating small equipments and glass blowing needed for various experiments. Green House and Animal House facilities are also lacking.

4. The budget allotments under recurring and non-recurring for various departments are hardly sufficient to run the day to day class work and it has not been possible to buy materials for research purposes. Therefore liberal funding for research, which has become expensive as a result of increase in the cost of chemicals and glassware, is absolutely necessary in the Basic Sciences.

In this connection it may be pointed out that a lump sum budgetary grant under staff research needs to be liberally earmarked for Basic Sciences and allotted in the beginning of the financial year itself to plan ahead.

Philosophy of Research

B. V. Venkata Rao*

The word philosophy is derived from the Greek word "Philo" and "sophy" meaning love of knowledge. The word 'Research' means study undertaken in order to discover new knowledge.

Though man is like any other animal in several respects, in one aspect, he is fundamentally different in that he is able to think, perceive relations among things and accumulate facts which he could interrelate and use them when the need arises. This helped him to understand the phenomenon of plant growth among other things in relation to environment, further modify environment grow crop plants which would produce him food he needed for himself and his domesticated animals. It paved way for the emancipation of man from a nomad to a human being living in harmony with his fellow beings.

Once he entered into the phase of settled life with a sense of security, he used his mental faculties for speculative thinking about things around him, his past and his future. The various systems of ancient philosophy in India, China, Egypt and Greece is an evidence of this phase of human evolution. It looks as though his attempts to understand the nature around him in all its fury, bounty and unpredictibility did not go as far ahead as his intuitive ability to speculate about things not within his physical perception. Theology, spirituality, metaphysics did have a sway about human mind for quite several centuries.

It is only in the past 3–4 centuries, man has been seriously attempting to gain insight about forces of nature around himself and modify the same to generally improve his living conditions.

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He has progressed beyond his mere limited physical manual power to do things and is in a position to use forces of nature do his things.

This trend is most striking in the area of agriculture. From the stage of individual foraging for food like any other animal, we are in a stage of total national effort to produce our requirements of food and other necessaries of life. We are on the threshold of a global outlook and strategy for feeding man. It would be appropriate to think of the role of agricultural scientists who have contributed a sense of food security in the world in the past one to two centuries through application of principles of physics, chemistry and biology to problems of soil and crop management in order to increase land productivity.

Society sustains agricultural research in a very big way. The outlay on agricultural education and research from the centre, states and other sources is easily of the order of Rs. 200–300 crores — approximately 10 per cent of all the money spent on education.

It is true the tempo of agriculture research in the past 15–20 years has gone up. In the late 1970s Green Revolution sparked off phenomenal increase in yields in several pockets of the of the country We have reached a stage of marginal surplus in regard to food grains from a stage of chronic deficit and imports. The need in future is one of stability arising out of sustained all round agricultural production and a rational population policy in relation to natural resources and our ability to exploit them.

This requires certain basic attitudes on the part of all those scientists engaged in agricultural research. Any look into the problems in the area plant or animal improvement needs a total integrated approach. As a student of soil science, the lack of such an approach, stands uppermost in my mind, particularly in the newly constructed irrigation project command area. Advent of water certainly paves way for intensive high production agriculture. People living in water hungry situation,

naturally cannot be expected to use water at the minimum levels required for maximising yields. Over-use of water leads to salinisation, alkalisation and waterlogging, reducing the the productivity of the lands to which water has been brought at enormous expense. Lack of balance in use of fertilisers leads to deficiency or toxicity of one or the other macro or micro nutrients, leading to reduced yields. Indifference to protection of reservoir catchment areas causes erosion and silting up, ultimately resulting the shortening of the life span of the project.

Last but not the least is the altitude of the individual research worker to the work he is pursuing. The objective of all research pursuit is to add to the store house of knowledge. The first aspect is identification of gaps in knowledge in the area of interest and formulation of a systematic programme of work. The second aspect is honest coordinated pursuit of the work in accordance with the programme. The third and more important point is the usefulness of the findings in offering solution to problems that confront day-to-day agriculture. The social relevance of what a research worker in agriculture is doing, is of over-riding significance.

In the context of the current seminar on Research Management the point that a scientist in general and an agricultural scientist in particular has to recognise that he is at once a teacher, researcher and administrtor in the sense that he has to work with people as a team and be able to record progress towards solution of problems confronting the farmer.

Working Paper on Problem Identification

J. Srinivasamurthy[1] and K. Krishnamurthy[2]

Research focus is on knowing the unknown Scientific procedure implies the adoption of objective methods and to follow analytical process to establish cause and effect relationship. The distinctive characteristics of Science are (i) experimental procedure and/or objective observation, (ii) analysis of the data generated through the use of statistical tests, and (iii) when logically relating the findings to the existing knowledge, *i.e.*, filling the gap in knowledge.

Over the decades, a commonly accepted research procedure has been evolved in the Scientific world. It involves (a) problem identification; (b) Selecting appropriate methodology for conducting research; (c) Undertaking experiment or survey to collect evidences; (d) Analysing the evidences so collected; (e) Reviewing the result of analysis with reference to the Objectives and the existing knowledge to state the findings of research; and (f) indicating the usefulness of these findings. This paper is however, focussed on the first step in this process.

We, in this University are mostly concerned with evolving Agricultural Technology and hence are concerned with the fundamental aspects of Agricultural Sciences and its application. Education Commission clearly states that "the Agricultural Universities should be entrusted with responsibility for the research facilities and programme of agricultural development" (Para 14-22) and Dr. Ralph W. Cummings, adds that Agricultural Universities recognize responsibility and in respect to the needs of the cultivators in contrast to being only a seat of learning and scholarship.

The problem identification step in any research endeavour in this University should recognize this frame of reference.

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Each discipline and the different fields of specialization in each discipline in this University should first seek answer to the Questions :

1. What are the agricultural development problems of the State which require solutions from us ?
2. What is the priority that we can work out keeping in view the needs of different agricultural zones of the State ? What kind of resources we have to work out a priority of research problems ?
3. What has been the approach of other countries/States to resolve the problems for which we are now concerned ? (Literature Review).
4. Have the experiences reported in literature review relevance to our specific situation ? Is the nature of solutions worked out elsewhere applicable to our Socio-economic situation ?
5. What is the set of hypothesis that we can formulate for testing keeping in view the Socio-economic factors ?

There are quite a number of problems which are of national importance. The same process is applicable. The State research becomes part of the national research programme. The role of UAS Scientists is important in the 4th and 5th steps for national research endeavours. We need to contribute in the deliberations of Workshops, Seminars and Conferences of All India nature by indicating approaches relevant to the specific needs of the State/our agricultural zones formulating specific hypothesis. When we fail to do so, the research results would not be so relevant to our State. Our research should aim to answer the problems of our different agricultural zones of the State.

It is worthwhile to examine a little closely the problem identification process. This process is extremely crucial because it provides the frame of reference for the research exercise that follows. Unless, the statement of the problem is clear, the researcher cannot identify the dependent variables, independent variables and intervening variables. Analysing the cause and effect relationship of the phenomenon under investigation is the

purpose of any research. 'Problem analysis', should lead to the stage where there is fairly a clear identification of factors which are likely factors that cause the effect. This leads to the foundation of general hypothesis. It may so happen that the problem analysis may indicte the need of inter-disciplinary approach. And the next logical step in the process is to have an inter-disciplinary team to be involved in problem identification state itself.

Agricultural Sciences is interdisciplinary. Farmer looks at his problem not in terms of Soil Science, Agronomy, Chemistry, Entomology, Plant Pathology, Microbiology etc. The technology that is evolved in research station should keep the integrated approach of the farmer, eventhough for purposes of indepth analysis we focus on narrow specialized aspects. The technology that is recommended should be an 'integration' of findings from several specializations related to be problem and not mere 'additions' to the package, In view of this requirement, the interdisciplinary deliberations at the problem identification stage becomes essential. This would enable each specialized department to develop proper perspective and formulate appropriate research in their respective areas.

This is the inverted pyramid of problem identification approach.

PROBLEM IDENTIFICATION PROCESS

Identification of Agricultural Development Problems of the State

Working out a list of priority of problems for each agricultural zone of the State

Literature review to find possible approach to solutions

Developing an approach relevant to the State and Socio-economic, considering each Agricultural Zone

Formulating Hypothesis for testing

Hence, when research projects are drawn up, whether it be postgraduate or Departmental one, it is desirable to have interdisciplinary discussion either informally or formally. In view of different agricultural zones in Karnataka the problems of each zone should also be identified. As mentioned at the outset, problem identification is an important process which establishes the needed frame of reference for the research efforts and the results of research to be of use should be preceded by proper proplem identification process.

Summary

1. Problem identification is a crucial process for the research efforts to be of any utility value.
2. Agricultural Development problems of the State should form the backdrop in problem identification of research work in U.A.S. (or in any agricultural university).
3. Priority of problems have to be worked out keeping in view the needs of the State, agricultural zones, and the resources available.
4. Socio-economic milieu should serve as the frame of reference for literature review in problem identification process.
5. Formulation of hypothesis for testing should be with reference to specific field situation for which research is needed.
6. Interdisciplinary deliberations are essential at the problem identification stage since the research findings have to be integrated before agricultural technology is recommended to farmers.

Procedure for the Preparation and Submission of Project Proposals for UAS and Outside Agencies for Funding

K. Krishnamurthy* and R. Vijayamma*

New Projects : The 'project approach' has been an accepted method for improving research since the establishment of the UAS. When a new project is to be initiated, it is necessary to give special attention to objectives and status of the problem based on a very careful review of literature, techniques to be employed, financial involvement, personnel available and others.

While preparing new project proposals, priority will have to be given first to such of those problems suggested at the Special Board Meeting, identified at Package of Practices Meeting, the problems suggested by State Development Departments, Directorate of Extension of the University, Farmers and other institutions in an effort to meet the situation systematically.

Project Leader : The person, who is most actively concerned with carrying out the project, should carefully prepare the project proposal, in the prescribed proforma strictly following the sugggestions provided therein. He has to take the suggestions from other scientists within his discipline, as well as from those of other disciplines who plan to co-operate on the project and who may be termed as Associates.

Now that the Head of each Department has been entrusted with the responsibility of having the Annual Meetings of the research workers, to finalise the technical programme, he will have to scrutinise the new research project proposals and

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recommend to the Director of Research, indicating relative priorities to enable him to place before Research Council for final approval, in the case of UAS supported projects. Whenever major problems requiring greater financial assistance are indicated, such project proposals may be sent to outside agencies for seeking financial assistance. They have to be routed through Director of Research, for scrutiny and countersignature before transmission to the concerned authorities. Blank proforma for sending project proposals to UAS, as well as outside agencies have already been circulated to all Heads of Departments and libraries for reference and needful.

The Heads of Departments while scrutinising the new project proposals, requiring financial assistance, should look into both technical and financial aspects carefully. In view of the 'financial stringency', it would be difficult to allocate the scarce grants available under the Directorate of Research, to the approved research projects by the Research Council. It has to be borne in mind that the new research project proposals are mainly meant to strengthen the research capability of the Research workers. It is desired that all the Scientists of different disciplines working on the concerned crop/animal meet first, before the meeting with Heads of the Department to review what has been done and plan what needs to be done. Heads of Departments should also see that each researcher will not have too many projects on hand. At the same time, all the staff may be encouraged to come forward with suitable project proposals looking into the needs of the State.

While sending the project proposals, care must be taken to see sufficient/prescribed number of copies are sent to the Directorate for needful. When the project is approved, Director of Research number will be assigned for the UAS supported as well as outside supported projects and communicated to the project leader for the operation of the project.

Approved Projects: After the project is approved and assigned a DR. No., it is necessary that the Head of the

Department has to assign a Head of the Department File No. for each approved Research Project. All the experiments taken up under an approved Research project should be serially numbered and the experiment No. will be expressed as a decimal of H.D.No. If any new experiment is added at any time, then it will have a continuation serial number. The DR No. and HD No. should invariably be quoted in all the proforma and correspondence, connected therewith. Each Department should have Directory of research projects and experiments and sent to all concerned.

It is also necessary, that a *Yearly research work plan*, outlining brief notes on how the project is to operate for the coming year, should be submitted every year. These yearly work plans are to be prepared using blank prescribed format for each experiment conducted in UAS, under UAS or outside support approved projects as per the directions given in the proforma. Only one copy of the *yearly research work plan* with the necessary approvals/certificates affixed need be sent to the Directorate of Research after retaining one copy each, with project leader, collaborative scientist, head of the Department, Director of Instruction concerned and head of Research Station if necessary.

For all the projects that are operating, progress made on each project, should be reported in the prescribed proforma *yearly project report* as per the directions given. If there are more than one experiment, reports should be prepared separately. The summary of the progress made should be brief and spell out clearly the progress of research towards the solution of the problem with a meaningful interpretation of the data, useful to the farmer. Only one copy of the *yearly project report* with the necessary enfacements affixed, need be sent to Directorate of Research after retaining one copy each, with the project leader, collaborative scientist, Head of the Department, Director of Instruction concerned and Head of Research Station if necessary.

When a project is completed/terminated, conclusion report should be submitted giving complete information on all the results obtained since the project was started, in the prescribed format, *Research project conclusion report* as per the directions given. Based on the results, appropriate recommendations should be made to the Directorate of Extension, for consideration at the Package of Practices Meeting. As in the case of *yearly research work plan* and *yearly project report* only one copy of the *research project conclusion report* need be sent to the Directorate of Research with the necessary enfacement affixed retaining one copy, each with all concerned.

It is hoped that the work, that is well planned and performed on schedule is most efficiently done and the results will be made productive and satisfying to all concerned.

Processing of the Project Proposals for UAS and Outside Agencies for Funding

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A project proposal is a document containing the problem, the experiments proposed to be conducted to find solutions to the problem, the personnel to carry out the research and the finances required, together in an organised manner.

A project proposal could be a long range one and of a continuous nature in which each year the experiments proposed to be conducted are indicated. In this it is essential that a proper sequence of experimentation is maintained. Ad-hoc projects are necessarily short term projects with a limited objective on a specific problem.

In the preparation of the project it is necessary that a particular sequence in the presentation of the information is followed. For this purpose both UAS and other financing agencies have prepared proformae and these have to be strictly adhered to.

In processing the project proposals some of the points of importance are listed below :

1. Identification and justification of the problems and the need for research on it.
2. The objectives should be clear and precise.
3. The background information should be presented in two parts : (a) by way of literature review, (b) work already done in the laboratory.
4. Item 2 will generally help in deciding the competence of the scientist proposing the project and hence should be given due importance.

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5. The technical programme is another important component of the proposal. This should be clearly written experimentwise or yearwise with the methodology proposed to be adopted. Quite often lack of clarity in this, makes a reviewer reject the project proposed.

6. The personnel proposed should be in tune with the volume of the work proposed. A disproportionate proposal in this regard could also result in the rejection of the proposal.

7. So far as finances are concerned proper justification for the money sought under each head should be given. Quite often a project proposal is sent with a view to equip a laboratory. This is incorrect. However, if a particular piece of equipment is required it should be justified.

Any agency which is funding research projects would like to have the information on the above points. This will help them to process the project speedily and effectively.

Research Techniques in Agricultural Sciences**

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Scientific research is the research for new knowledge. The basic research aims at better understanding of the phenomenon being investigated, elucidation of general principles or theories without any regard to its applicabilty. Many practical problems can, however, be solved by first understanding the underlying principles. The applied research aims at application of science directly to the solution of the practical problems. The level of research may vary from the most simple to the complex one needing co-ordination of different disciplines or in depth studies. Agricultural Research is said to be a meeting place of physical, biological and human sciences in their relation to progress of people through agriculture. The objectives of agricultural research are : (i) To increase production per unit area, animal and water; ii) To increase efficiency of production by reducing cost on inputs ; (iii) To increase the stability of production ; and (iv) To improve the quality of production. Scientific method is adopted in research which is based on inductive-deductive process involving collection of facts based on observation or experimentation, formulation of hypothesis that explain the facts, deductions from the hypothesis and its verifications. Various techniques are adopted in agricultural research and some of them are briefly described below :

Pot culture-Green House Lysimeter studies : These are taken up under conditions like large number of treatments to be tried, to have grater amount of control over the treatments to understand basic principles underlying the problem etc. In pot culture studies, kind and size of pots, lining of pots, drainage, are important besides soil preparation, watering and application

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of nutrients and number of plants per pot. Lysimeter studies are particularly useful for measurement of evapotranspiration of crops, root studies of crops, long range effect of applied nutrients etc. The soil profile of the rooting depth is used in lysimeters and is thus better than pot culture studies. The use of glass house gives a control over the environment like temperature and light factors. Bird proof cage directly accessible from glass house is advantageous.

Techniques in plant breeding : The crop varietal improvement through introduction, hybridization, back crossing, production of hybrids is taken up. Strong units in biometrics, radiation genetics and cytogenetics ; establishment of germ plasm banks in different crops and laboratory facilities for quality analysis will greatly help in plant breeding work.

Techniques in Entomological and Pathological research : Studies in surveillance, monitoring and control methods for pests and diseases are taken up. Screening of germplasm and pre-release varieties for major pests and diseases occurring in the region is essential. Use of light traps to identify the presence and built up of pests, insecticidal screening to assess the toxicity of insecticides, sex attractant traps and sterilization techniques are important in entomological research. Built up of information on life tables of pests and studies on the epidemiology of crop diseases are important. Integrated control of pests and diseases including biological control are investigated.

Field Studies in Agronomy, Soils and Agricultural Engineering: Micro plot studies are taken up by when large number of treatments are involved. Some studies in splash erosion etc., can be conducted in metal rings or frames. Large sized plot experiments are conducted in agronomy and the data are supported by ancillary data on yield attributing factors, uptake of nutrients moistute use etc. Field trials are repeated over the years and effect of season estimated. Long term studies which give direct, residual and cumulative effects of treatments are useful. In crop rotation studies each phase of the cycle is repeated each

year. Experiments on farmers' fields are important so as to get the treatments tested under actual farm situations and scattered over large area. Studies on soil test-crop response need be conducted on farmers' fields in large numbers. Basic laboratory studies in soil fertility will support the field studies. Studies on water management and soil conservation are to be conducted in large sized area so as to be more meaningful. Use of water measuring devices, run-of and silt measuring equipments is essential.

Studies in Social Sciences: Data on the opinion surveys are collected. The farm structure studies and price analysis are taken up over a period of time. Farm accounting studies are taken up through survey. Whole farm demonstrations are taken up with selected farmers, having different sized holdings. Evaluation and economics of the new technology introduced as compared to the traditional practice and studies on the constraints in not adopting the technology are essential.

Operational Research Project: The Operational Research Project is taken up outside the research station to test the research findings. It is aimed to know how far these findings can be practiced by the farmers under his conditions. The feed back information is useful for changes to be made in the research programme. Multi-disciplinary approach is usually adopted in these studies.

Conduct of Experiments, Experimental Designs and Recording of Observations

N. Sundararaj*

A Quotation: "One cannot imagine any more of a fool's paradise than to experiment or investigate in whatever direction the mind may wander, without any pupose or objective. Such meandering investigations lead to naught but a wastage of funds and resources".

(By A. C. Hildreth, Biologist)

I am rather tempted to start with a well known proverb: "Think before you ink". In the context of experimentation this could be expanded to mean a prior organization of a complete sequence of steps taken well in time to ensure that appropriate data is obtained in a manner which permits an objective analysis of experimental data leading to valid inferences.

In what follows I intend to divide my presentation into two broad aspects:

(i) Requirements of a good experiment and (ii) some useful experimental designs.

I. Requirements of a Good Experiment: What are the requirements of a good experiment? or when can we say that an experiment is satistically a sound one? These requirements, of course, may be defined in many ways depending upon a particular emphasis one may desire to represent. However, it suits my requirements to borrow the ones listed by Cox (1), for they appear to me to be convenient, logical, succinct and purposeful. These requirements which we may call broadly the PANCHA

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SHEEL of a sound experiment are : (a) Absence of Systematic Error, (b) High Precision, (c) Range of Validity, (d) Simplicity and (e) A Measure of Uncertainty.

(a) **Absence of Systematic Error** (Number One Enemy): Many of the experimental investigations in the early stages suffered severely from systematic bias. These could arise in any, rather in fact, many stages of experimentation. Examples are plenty and early literature abounds with such examples (2). However only a few that pertain to the design stage will be cited here to bring out forcefully the essential nature of such systematic biases.

Example 1: (Field Lay Out) A typical example of a systematic bias due to an error in the lay out pattern in a comparative trial is brought out in the following systematic arrangement of three treatments A, B, C.

Rep I			Rep II			Rep III		
A	B	C	A	B	C	A	B	C

It is easily noted that any correlation that may exist between neighbouring plots leads to a systematic bias in assessing treatment differences. For instance, if the fertility gradient runs low from left to right, treatment A is always assigned to a relatively superior plot, in every replication, than treatment B and so on ; so that the difference between the observed means for A and B (say) contains this systematic component also ; and much worse is the fact that there is no way of either estimating this from the observations or otherwise making adjustments for this component in the observed difference (irrespective of the number of replications !).

Variations in the arrangement of this kind of design are also there, as for instance, Beavan's Chess Board Design and A B B A design etc. (2).

Example 2: (Group Formation of Animals in Grazing experiments): An animal scientist often strongly desires to 'balance' (?) the factor of 'average initial weight' of groups of animals, say in a pasture grazing or feeding trial. A commonly used method of balancing is to arrange the weights of the animals in order of magnitude and then the highest and the lowest are grouped and so on. The systematic bias introduced in such experiments is, of course, not obvious. This kind of arrangement is known to have the effect of making the lots more variable in some cases – as, for instance, the group made up of large and small animals may not behave the same way as the one made up of entirely medium-sized animals.

Example 3: An instance where a systematic bias creeps in without obvious recognition arises in laboratory experiments. Greenberg (3) in his article "Why Randomize?" mentions an illustration of a systematic bias of this nature. The experiment consists in choosing pairs of mice of the same sex, one member of the pair receiving a certain treatment T and the other left untreated as a control C. Each mouse then receives a 0.05 cc of solution, supposed to contain a standard number of larvae. The effects of T are measured as the average difference in some chosen response. The common practice to assign the treatments is to use the order TC, TC, TC...with the hope of balancing (?) variations in the dosage. What is ignored here, and experimental evidence available to this effect, is the steady and systematic variation with greater injection of larvae to the control mice!; this in turn causing difficulties in attributing the difference (T – C) to T effect only since the systematic component gets confounded with the genuine difference (if any).

Example 4: It is not uncommon that, while recording of observations in experimental plots, separate individuals record observations on separate treatments. For instance, individual A might collect observations on treatment K while individual B might do it on the treatment H and so on. The difference (K – H) will then contain a systematic component (A – B)

attributable to the ideosycratic difference of the two individuals A and B.

A similar bias will also persist if, for any convenience, harvesting of all plots under treatment A is first done to be followed by harvesting of all plots of treatment B and so on. The fatigue effect (which may be a continuous process) will affect the observations in a systematic way.

These are but only a few illustrative examples to emphasize how, even an otherwise well conceived and well executed experiment may be rendered worthless in its scientific value by the presence of a systematic bias.

It is in this context that Fisher introduced the revolutionary concept of RANDOMIZATION as the first CARDINAL principle of experimentation. Randomization, in fact, has a two-pronged advantage: first, to thwart the influence of the Number One Enemy *viz.*, systematic bias and second, to provide a sound probability basis for drawing conclusions from experimental observations.

(b) **High Precision:** The second requirement of a statistically designed experiment is high precision. Roughly, precision refers to the repeatability of a measurement. Low precision means there is wide variation in repeated measurements on the same object and high precision means that there is little variation among repeated observations. Statistically, this is measured by the standard deviation among the replicated observations.

Accuracy – a term often used as a synonym with precision– is reserved to indicate the totality of systematic error plus precision (4). Schematically, high and low accuracy may be represented as follows :

—	Large Bias	*Plus*	Low Precision	*leads to*	Low Accuracy
—	Large Bias	*Plus*	High Precision	*leads to*	Low Accuracy
—	Zero Bias	*Plus*	Low Precision	*leads to*	Low Accuracy
—	Zero Bias	*Plus*	High Precision	*leads to*	High Accuracy

Thus for high accuracy bias needs to be eliminated ensuring at the same time high precision.

A pertinent question then would be about the means of achieving high accuracy in experimental observations.

Systematic bias, as noted earlier, is largely eliminated by the principle of randomization. Thus randomization should never be sacrificed except for an exceptionally good reason. High precision may be realized by the application of a combination of the following principles :

(1) Precision may be improved by the reduction in the variability of experimental material.

(2) Precision may be improved by increasing the number of replications.

(3) Precision may be improved by a suitable choice of an experimental design.

Often an experimenter does not seem to pay adequate attention to achieve high precision for every observation in an experiment.

As to Method (1) : One of the chief sources of inherent variation lies in the material used for the experiment. So

wherever possible uniformity of experimental material should be ensured. For instance, variations in quantity of seeds used per plot, variations in the selected mode and mechanisms in the applications of fertilizer (when not a part of treatment variations), variations in the weighments of the quantities of fertilizers applied to plots, lack of uniformity in the preparation of plots for receiving treatment allocations - all these and an umpteen number of other variations in the experimental materials used cause individually and conjointly variations in the response variable(s) affecting the precision of observations. Precision can be improved largely if such variations are controlled in the experimental materials used.

As to method (2): It is well known averaging of observations cancel out errors of random nature ; an average based on a larger number of replications is thus more reliable than one based on fewer number. It is not uncommon that such weighing devices such as tea spoon measure, table spoon measure, pint, quart etc., all have imperceptible contributions to imprecisions. Even a chemical balance has such errors.

In Plant Pathology experiments, for instance, the measurement scales devised for the assessment of damage caused to plants by diseases have potential sources of errors affecting the ultimate precisions of the observations. As is well known, these assessments are frequently made using scales developed on one of the four levels of measurements, *viz.*, nominal, ordinal, interval and ratio scales. The disease assessment is often done on a nominal scale (*e.g.* affected/not affected) or on a ordinal scale (*e.g.* low/medium/high) or on an interval scale (0–1–2–3–4–5–6). Assessment on any of these scales is heavily loaded with subjective element of the user and the level of skill attained in using this etc. A good number of replications (*i.e.* plants) is desirable if one would like to ensure high precision in the estimate of the damage ascribable to a specific disease.

Imprecision is also caused by incomplete observations. For instance, while harvesting for grain yield, either plantwise or

plot-wise, it may be impossible to harvest every grain in every plant or plot. Unless the incidence of these errors is non-random, increasing the number of replications ensures increased precision. As precision is measured in terms of standard deviation of observations and since the standard error of mean is *inversely* proportional to the (square root) number of observations (*i.e*, replications) it is possible to determine before hand the number of replications required to achieve a desired level of precision; provided a rough idea of the standard deviation of the individual observations is available. In the absence of any such knowledge, the rule of thumb for determining the number of replications, appropriate to the selected experimental design, is that it should be adequate to provide at least twelve degrees of freedom for estimating the error mean square. This insistance of twelve degrees is made because F test is highly sensitive (*i.e.* F values fluctuate erratically) for degrees of freedom less than twelve. It is rather revealing and instructive to examine the F table under each column from this point of view.

It is in this context that Fisher introduced the second most important principle of *Replication* as a means of ensuring high pricision and also to provide a basis for estimating the variations due to uncontrolled factors.

As to the method 3: Method (1) has the limitation in the reduction of error, Method (2) may become costly. But given a certain number replications, precision can be increased by devising improvement in the design of experiment. As is well known, the grouping of plots into homogeneous blocks as in randomized block design, the error mean squares will be lower than one would obtain when no such blocking is employed as in completely Randomized Design.

Fisher and Yates in the early stages and R.C. Bose (5, 6, 7) subsequently revolutionized the very foundation of experimental techniques in agricultural research by creating a number of confounded and other complex designs.

A careful planning thus calls for full exploitation of these three principles *viz.* Randomization, Replication and Local Control.

(C) **Range of validity:** By range of validity, we mean, the extent to which conclusions drawn from an experiment could be generalised to hold for other conditions. The wider the range of conditions investigated in the experiments, the greater will be the possibility that its conclusions could be 'extrapolated'; larger, in turn, will be the cost-benefit from such experiments (*i.e.* amount of information per rupee investment).

Some illustrations are worth noting.

Example 1: Van der Plank (8) noted that if treated plots in an experiment are not representative of similarly treated farmer's fields, then this constitutes what he terms as 'representational errors'. This error, however, should not be confused with the familiar 'experimental errors' which arise because of many uncontrolled sources of variations and which constitute a sound statistical basis for comparison of treatments. The latter, of course, is measured in terms of standard errors. Thus representational errors affect severely the range of validity of experimental conclusions.

Example 2: 'The blowing up of average yield of a variety or of observed difference between the averages of two varieties computed from micro-plots experiment to a magnitude of several-folds to an acreage or a hectare basis often leads to unnatural differences that are never realised in such larger field plots as an acreage or a hectare, especially in farmer's fields. The reasons are obvious, *viz.*, the conditions of the plots obtaining in the farmer's fields do not approximate to the same degree as in the micro-plots. This type of 'blow-up' may be accomplished with greater confidence, if micro-plot experiments are designed and tried in several locations randomly selected using the sound principles of many available sample survey schemes (9).

Example 3 'Student' (10) mentions an interesting experiment (also quoted by Cox) which is reproduced here for it illustrates how range of validity is severely affected. Irish Department of Agriculture was eager to introduce a particular variety of barley (Spratt-Archer variety) in all districts where it was a great success; notwithstanding with this general success in many districts this variety did not find favour with local farmers in a particular district, who preferred their own local variety. When a demonstration trial was conducted in that district to induce confidence in those farmers, the department staff, to their utter surprise, found the farmers to be right and the native barley gave higher yields. When reason was looked for, the officials discovered that the local variety grew quicker and was able to suppress the weeds which was growing in plenty in that part of the district; the Spratt-Archer variety, which was slow in establishing was smoothered by the weeds in the early stages of growth itself. Thus the conditions of the original experiments which were conducted under well-managed farming conditions in the experimental stations lead to this kind of mistake when the results were 'extrapolated' to a different set of conditions obtaining elsewhere.

Example 4 (Plot Size and Shape) : Plot size and shape are also known to contribute to experimental error and affect extrapolation to a larger plot size. It has been noticed in crop-cutting surveys reported by Mahalanobis (11), Sukhatme (12) and others too, that blow-up errors have been particularly noticed to be related to the initial size and shape of plots selected for estimating the crop yields; and it was noted that smaller plot size and circular shape plots have a tendency to overestimate the true yields when 'blown-up' to larger plots of several folds bigger. Although for comparative trials this need not affect so much at the micro-plot levels, care should be exercised when observed differences are 'blown-up' for disseminating information to the farmers for their understanding of varietal differences. Again this emphasises the importance of conducting large scale trials in representative plots randomly

selected as a sequel to the outcomes of micro-plot experiments in the research stations.

Analysis of a large number of experiments over a long period of time at Rothamstead Experimental Station in England (9) has revealed that plot errors have decreased from 10 per cent to 5 per cent of the mean and is attributed mainly to the advent of 'the combine harvester and the need for long, fairly narrow plots'. Uniformity trials carried out recently in UAS on cow pea and also sunflower have revealed similar results.

Example 5 (Inter-Plot-Interference): In comparative experiments, one of the crucial assumptions made is that the observations made on one unit are unaffected by the treatments applied to other units. In many experiments the experimental units are physically different and this assumption is generally satisfied. But in some experiments, by their very nature, this assumption may be under a shadow of doubt. For instance, the experiments concerning with the disease assessment and control, the disease caused by air-borne pathogens, do cause and contribute to the violation of this assumption. This, in turn, affects the objective assessments of treatment effects; and this will affect the range of validity of the conclusions that one can draw from such experiments.

Field experiments specially designed for the study of the effects of 'Interplot-Interference' (13, 14, 15) have clearly shown these effects to be substantial. For instance, physical proximity of plots—'sprayed' and 'unsprayed' plots in fungicide experiments—have known to cause such errors in sprayed plots. The yield loss associated with fungicide treatments are overestimated (termed positive interference) if the adjacent plots have more diseases or under-estimated (termed negative interference) if they have less diseases.

Example 6 Interplot Interference is also noted even in cultivar trials for screening for resistance, even when fungicidal treatments are not involved. This is so because of physical proximity of (possibly) the 'most' and the 'lest' susceptible

cultivars which are analogous to the conditions of 'unsprayed' and 'sprayed' plots respectively.

Example 7: Interplot interference may also be present in experiments designed to determine optimum 'male-female' ratio and plot locations in seed multiplication trials; In such experiments if the isolation-distance between plots is not maintained with a safe distance apart, then plot interference effect is possible. If the distance is long enough, then it will raise the other important questions pertaining to the heterogeneity of plots.

Example 8 (Multilocational Trials): For experimental conclusions to be valid over a wide range of conditions it has long been recognized that it is necessary to conduct multilocational trials not only for determining the 'best variety for best place', but also for increasing the range of validity. Such experiments will also generate data with one or all of the following features:

(a) environmental errors may be homogenous or heterogenous over space and time.

(b) the response to treatments may vary from place to place or from season to season or both. The analysis problems of statistical nature are quite complex.

Many of the problems will be kept to a minimum if the other basic conditions in such experiments like plot size and shape, the basic design employed etc., are all kept identical.

From the above examples, it is hoped that the central idea of the range of validity is brought to focus for future planning of field trials.

(d) **Simplicity:** The fourth important requirement of a good experiment is simplicity — of what? of everthing? More easily said than done!! As far as possible it is desirable that:

——— the objective(s) of the experiment, however complex it might be needs to be stated in as simple a format as possible

——— it should lend itself for verification by experimental procedures

——— measuring devices, wherever possible, should be simple. Or else, complicated devices requiring high skill and special training make it more difficult

——— if the layout of the field experiment requires the services of semi-skilled and unskilled persons, simpler the design, better the handling and the execution of the experiment; or else it may be difficult to ensure the adherence to a series of complicated schedule of requirements. For instance, Randomized Complete Block Design is a lot more easy and flexible than a more complicated design. Not only its lay-out simple, but also its analysis even in the even of some accidental damages to the plots resulting in missing of some observations.

——— sometimes even the most elegant and elaborate design may be rendered worthless by accidental damages caused to the experimental units.

(e) **A measure of uncertainty:** A well executed experiment will not be complete in itself unless the outcomes are assessed in an objective way. Associated with such conclusions is an element of uncertainity which is normally expressed in terms of 'level of significance' which is a probability measure reflecting the risk of unwise decision to reject the hypothesis of no difference when, in fact, there is none.

It may be pertinent to caution here about the *'blind spot'* in the mode of inference using test of significance. It should be kept in mind that 'acceptance of null hypothesis' does not automatically establish the truth of the statement. 'There is no genuine difference between the two treatments; it merely asserts that the experimental evidence does not establish the observed difference as *necessarily* a genuine difference.

Often, in experiments involving fertilizer applications a hypothesis of NO DIFFERENCE is made. In fact it is a

pointless hypothesis to formulate when, in fact, hundreds of such experiments already conducted have established beyond doubt the fertilizer effects. What is required in such cases is to formulate new type of hypothesis which will either relate the fertilizer dose with specific type of response or to set confidence intervals on the unknown magnitude of the true difference between fertilizer effect and the control.

Yates's (16) observations are particularly relevant here. In his obituary note to Fisher he observes that the application of Fisherian method had led to 'an undue emphasis on tests of significance' and proceeds further to imply that some experimenters are more obsessed to pursue the test of significance than to pursue the main object of the experiment itself;' one cannot see woods for trees!

A word of self-advice and advice for fellow-research workers. The role of a statistician is critical in scientific experimentation involving statistically designed ones. Hence a caution of self-advice is pertinent. The art of application of statistics is compounded of two things — a sound knowledge of statistical methodology and at least an appreciative knowledge of the data to which this methodology is to be applied. Blind application of a method, however good the scholar he might be, often leads to erratic and unrealistic conclusions. This folly would be no less ridiculous than concluding that a person made to stand with his one foot in ice chamber and the other in a burning coal has a comfortable 'average' temperature in his body!

A word of request to our fellow researchers. In the experience of many statisticians, research workers have a tendency to approach them only at the end of the experiment — as a fait accompli — when to their surprise and sometimes to their annoyance when some serious statistical lapse in the experimental designs is pointed out, which of course, invalidates statistical analysis of the data. It is also not uncommon that a scientist, uninitiated into the structural logic of statistical methods, often is under the impression that

statistical methods come into operation only at the end of data collection and the statistician is adept (!) to manipulate data to get some significant results — probably even when there is none!! More often than not, some go to a statistician (with all his conclusions already made up in his mind) only because it is a necessary evil for getting the report accepted or an article published.

Until a scientist becomes his own statistician, it is in team spirit that scientific success lies.

II. **Some useful experimental designs:** I shall now turn on to the second aspect of this paper *viz*, some useful experimental designs.

The growing concern of statisticians and statistically oriented experimental scientists is to invent new types of designs and to improve upon the existing ones. In this paper I shall restrict myself to only three types of designs which seem to have wide application potential in the field of agriculture.

(A) **Augmented Designs:** In plant breeding trials involving a number of new strains or in experiments involving evaluation of a number of new pesticides (or dose levels) or new fumigants, problems are of different types:

——— if the material available (*e.g.* seed quantity etc.,) from new strains is insufficient to have more than one replication, then some of the usual designs may not be of help since they need more than one replication.

——— it is possible that expenditure involved for each additional observation is so prohibitive in experiments involving say 300 to 1000 new strains, it may not be economically feasible to carry out more than one replication; more so if the main objective is to retain a few strains ultimately by eliminating the unpromising ones.

——— in the case of fumigants some of which have got harmful effects on plants (*e.g.* killing effects on trees or rendering it less yielder at the end) it would be an

economic loss to try these fumigants on a number of units (trees) when it is still in the preliminary trial stage.

——— so that by necessity it may be advisable to restrict such trials to a single replication. In such cases, the nature of statistical problem is different and the design requirements are also different.

Augmented designs are a special class of designs to deal with such requirements. Only a few are listed below to bring out their general features etc.

(1) **Augmented Randomized Complete Block Design :** By way of illustration, suppose 100 new strains are to be compared in a single replication. Besides these 100 strains, suppose that seed material for five comparable standard strains A,B,C,D,E (say) are available in sufficient quantities for more than one replication. An augmented RCBD design may be constructed as under : (Plan before randomization).

BLOCKS

I		II		III	. . . . .	IX	X
A		A		A		A	A
B		B		B		B	B
C		C		C		C	C
D		D		D		D	D
E		E		E		E	E
1		11		21		81	91
2		12		22		82	92
3		13		23		83	93
.		.		.		.	.
.		.		.		.	.
.		.		.		.	.
10		30		30		90	100

In each of the ten blocks, each block having (5+10) plots, the five standard strains A,B,C,D,E are first allotted randomly among the 15 plots. Then numbers 1 to 100 are randomly assigned to the 100 new strains ; and strains 1 to 10 are distributed randomly in the ten vacant plots in block 1 ; strains 11 to 20 in block 2 and so on, with strains 91 to 100 in block 10. Thus there are ten replications for the five standard strains and only one for each of the 100 strains.

The analysis of such a design undergoes modification, the standard error formulae being different for :

(1) comparing two new strains which appear in the same block.

(2) comparing two new strains which appear in different blocks.

Complete and general theory of such designs are reported in (17).

(2) **Augmented Latin Square Design (one square) :** In this augmented design, the five standard strains are first arranged in a LSD, as under. Then in each of the intersecting cells, five plots are created, of which, one is occupied by the standard strain ; the new entries occupying the four plots, all in a random fashion. In the following figure, the distribution of the standard strains as also the new strains are shown.

A 1 to 4	B 5 to 8	C 9 to 12	D 13 to 16	E 17 to 20
B 21 to 24	C 25 to 28	D 29 to 32	E 33 to 36	A 37 to 40
C 41 to 44	D 45 to 48	E 49 to 52	A 53 to 56	B 57 to 60
D 61 to 64	E 65 to 68	A 69 to 72	B 73 to 76	C 77 to 80
E 81 to 84	A 85 to 88	B 89 to 92	C 93 to 96	D 97 to 100

Single cell

A
1
2
3
4

a plot

(3) **Augmented Latin Square Design (more than one square):** Instead of one LSD more than one square may be created. In each square the standard strains are arranged in LSD fashion and the new strains being evenly distributed to the square as shown in the following figures :

Square (1)	Square (2)
As in (2) above with two strains in place of 4 being allotted to each cell. This square will take strains from 1 to 50.	As is (2) above with two strains in place of 4 being allotted to each cell. This square willl take strains from 51 to 100.

As in the augmemted RCBD, the mode of analysis needs modifications.

(4) **Other Augmented Designs :** It is possible to generate and generalize such designs to other basic types such as Augmented BIBD and PBIBD etc. (17).

(B) **Repeated Measurement Designs (RMD) :** This is a class of experimental designs in which the same experimental unit (*e.g.* tree, plot or animal) used repeatedly by exposing it to a sequence of different or identical treatments. The statistical analysis of such a design would call for special format since the observations are no longer mutually independent. The need for such designs may arise due to variety of reasons as for instance :

—— Budget limitation : the same tree or the same animal needs to be used repeatedly because each unit is expensive.

—— such experimental units may not be available in sufficient numbers.

—— the main objective may be to study the long term effects of a sequence of treatments on the same unit (*e.g.* growth analysis etc,).

Such designs may be classified into two broad types :

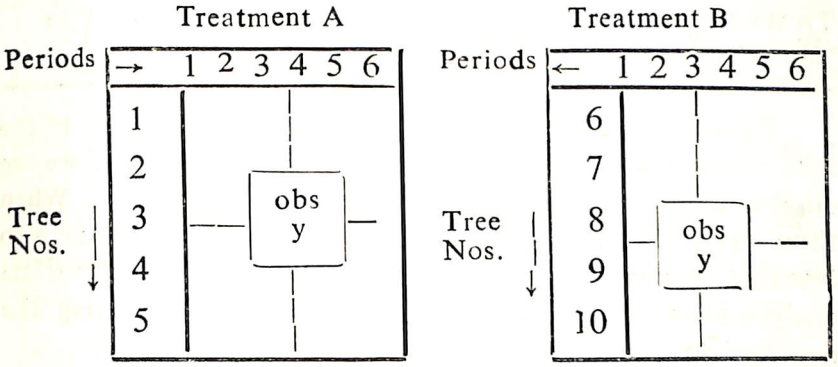
Type (a) : Repeated measurements are being made on the same unit as in growth analysis studies. Here time is the new dimension.

Type (b) : The same unit is subjected to a sequence of treatments of in crop rotation experiments.

The mathematical exposition as these designs may be found in ( ).

I shall present here only two examples, one for each type, merely to focus the attention of the main features of them :

Example 1 : (Type a) : Table below shows the data generated by an experiment involving two treatments A and B with 5 trees for each (hypothetical) in which each tree has been observed for a certain character once in two months–six times in a year. A commonly committed mistake in the analysis of such experiments is to analyse it as a factorial experiment with 2 trt × 6 periods. The following ANOVA table is shown below :



ANOVA Table (Wrong Analysis)

Source of Variation	df	MSS	F-Ratio
Treatment (t)	1	MSSt	MSSt/MSSE
Periods (P)	5	MSSP	MSSP/MSSE
Treat × Period (t × P)	5	MSSt × P	MSSt × P/MSSE
Error	48	MSSE	
Total	59		

The various mean sums of squares are computed in the usual way and the effects are tested by computing the F-Ratios as shown in the last column. This is a wrong analysis, since the repeated observations on the same tree over six occasions are no longer statically independent.

For a correct analysis, the method depends upon the mild assumptions we might make as under.

Analysis one: If it is resonable to assume that the extent of correlations is of the same magnitude between any two periods of time, then the data can be analysed as a Split Plot analysis with trees as the main plots. The ANOVA table looks like:

A Split Plot Type of Analysis

Source of Variation	df	MSS	F–Ratio
Treatments (t)	1	MSSt	$MSSt/E_a$
Treat within Treat (T)	8	$MSSTE_a$	
Periods (P)	5	MSSP	$MSSP/E_b$
Treat × Period (t × P)	5	MSSt × P	$MSSt \times P/E_b$
Treat × Period (T × P)	40	MSSE E_b	

The treatment effects are tested aganist the error E_a. If the assumptions about the correlations are satisfied then only we are eligible to test the other effects against the error E_b. When these assumptions are violated then this analysis becomes also invalid. Alternatively, it may be analysed as a multivariate analysis of variance (MANOVA) with periods constituting the multivariate vector of observations (18).

Example Type (b): In this design, the main feature is that the same experimental unit will be subjected to a sequence of treatments. In what follows an experiment is designed in which eight treatments are tried with only eight experimental units (here trees being made available), The treatments are applied in a special sequence as shown below.

Units (Trees)

	1	1	2	3	4	5	6	7	8
P	I	(A)	(B)	(C)	(D)	(E)	(F)	(G)	(H)
E	II	(B+a)	(C+b)	(D+c)	(E+d)	(F+e)	(G+f)	(H+g)	(A+h)
R	III	(D+b)	(E+c)	(F+d)	(G+e)	(H+f)	(A+g)	(B+h)	(C+a)
I	IV	(C+d)	(D+e)	(E+f)	(F+g)	(G+h)	(H+a)	(A+b)	(B+c)
O	V	(E+c)	(G+d)	(H+e)	(A+f)	(B+g)	(C+l)	(D+a)	(E+b)
D									

Note: Capital letters represent direct effect, small letters the residues effect.

In this type of design, there will be several effects :

—The Direct effect of the treatment applied at the point of time. These are denoted by the capital letters in the above table.

—The residual effects of the immediate preceding treatment received by the Unit. These effects are indicated by the small letters in the above table.

—Cumulative residual effects of all other treatments applied to the Unit. This is not shown in the table. It is generally assumed that the treatments do not have permanent long standing residual effects, beyond the first residual effects. Otherwise both designing and analysis of such data become extremely complex.

The analysis of such designs need special treatment. The intention here is merely to emphasize that statistical designs are available for such experiments also.

(C) **Fractional Replications:** Another class of designs whose theory is exhaustively worked with a number of fully described designs available in published literature and standard text books but not fully exploited in the field of agricultural experimentation is Fractional Replication Designs (19).

As we all know a number of — literally hundreds of — complete factorial experiments of the type. 2^3, 3^4, 5^3 involving

2, 3, 5 factor levels have been tried in the past as also in recent years to understand the nature of relationship between fertilizer levels and yield responses for variety of crops. Such experiments, though useful in themselves, have put a great limitation on the number of factors and the number levels of each factor to be included in a single experiment. For instance, a 3^4 experiment involves 81 treatment combinations and a 5^4 experiment involves 625 treatment combinations. To include all of them in one complete replication may be prohibitively expensive and in fact may not be necessary under certain circumstances. For instance, when the higher order interactions are known to be negligibly small (as is true from many past experiences), even a 1/5th replicate with 1/5th (625) or 125 treatment combinations or sometimes 1/25th replicate with 1/25 (625) or 25 specially chosen treatment combinations may give adequate information on the main effects and the lower order interactions. Such designs which make use of only a fraction of a complete replication are called Fractional Replicate Designs.

To bring out its salient features as well as its limitations, consider a simple 2^3 experiment involving three factors, each at two levels only. Table below setsforth the addition and subtractions of treatment (means) schemes to estimate various effects denoted by A,B,C, AB, BC, AC, ABC when a complete factorial experiment is used.

Treatments

	(1)	a	b	ab	c	ac	bc	abc
E GM	+	+	+	+	+	+	+	+
F 1/2 B	—	+	—	+	—	+	—	+
F 1/2 B	—	—	+	+	—	—	+	+
E 1/2 AB	+	—	—	÷	+	—	—	+
C 1/2 C	—	—	—	—	+	+	+	+
T 1/2 AC	+	--	+	—	—	+	--	+
S 1/2 BC	+	+	—	—	—	—	+	+
1/2 ABC	—	+	+	—	+	—	—	+

For instance, $\frac{1}{2}$ ABC effect is estimated by (rearranging the terms with plus and minus signs separately) the expression in the last row *viz.*,

$1/ABC = [(abc + a + b + c) - (1 + ab + ac + bc)]$ (1) Similarly,

$\frac{1}{2} A = \frac{1}{4} [(a + ab + ac + abc) - (1 + b + c + bc)]$ (2)

$\frac{1}{2} BC = 14/ [(1 + a + bc + abc) - (b + ab + c + ac)]$ (3) etc., etc.,

Suppose we decide to use any half—replicate with four of the eight treatments *viz.*, (a, b, c, abc). That is we decide to use these treatments in, say a randomized block design. The question that may now be asked is: What kinds of information this experiment generate? To know we proceed as under:

i) adding A effect and BC effects we estimate $\frac{1}{2}$ (A + BC) effect. [add these expressions shown in equations (2) and (3) $\frac{1}{2}$ (A + BC) is estimated by $\frac{1}{4}$ (a − b − c + abc)].

ii) Likewise, $\frac{1}{2}$ (B + AC) is estimated by $\frac{1}{4}$ (− a + b − c + abc).

iii) Likewise, $\frac{1}{2}$ (C + AB) is estimated by $\frac{1}{4}$ (− a − b + c + abc).

iv) Likewise, $\frac{1}{2}$ (μ + ABC) is estimated by $\frac{1}{4}$ (a + b + c + abc)

Thus, from the any four treatments (a, b, c, abc) we may estimate the effects (A + BC), (B + AC), (C + AB); But at the same time, there is no way of apportioning what part of, say, (A + BC) is contributed by the main effect of A and what part of it comes from the interaction effect BC. Similarly for the other effects.

Suppose it is known that the interaction effect AB is negligibly small (from past experimental evidence or from the nature of treatment combinations involved) then the quantity estimated by $\frac{1}{4}$ (a − b − c + abc) may be attributed to the main effect of factor A; similar interpretation holds good for the other effects also. In other words, in experiments involving many factors, the higher order interactions are generally absent so that a fractional replications may be constructed to estimate

the main effects and lower order interaction effects whose effects are not negligible.

The main intention of this simple illustration is merely to bring out this feature of the fractional replication designs. Although the main effects and the lower order interaction effects may not be separable as separate components, the experimenter may just be interested in merely trying to know the chosen combinations of such effects; and a fractional replication design will become economically less expensive.

In the above structure, the effects A and BC are called aliases to each other; likewise B and AC are mutually aliases to each other and C and AB are aliases.

In conclusion, I wish to say that in this paper I have tried to focus attention of the research workers on a few important points for consideration while planning an experiment; I trust that this proves useful to my fellow-researchers, although there are many more technical details to go with complete experiment, for which I pretend no knowledge or confidence.

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Transfer of Research Technology to Extension and Linkages to be Developed with the State Government Departments

K. A. Jalihal*

Research technology when developed by the research stations has to find application in the field in order to benefit the farming communities. This process of application of research knowledge by the farmers can only be done through transmitting this research knowledge to extension. In this task of transfer of research technology to extension, several stages are involved and also in implementing this programme linkages have to be developed with the State Government Departments. This paper tries to deal with these aspects in a brief way:

I. States in the transfer of research technology to Extension

1. New technology developed at research stations must be shown and explained at the field days organised at research stations: One of the objectives of field days to be organised at research stations is to provide an opportunity to extension workers and farmers to preview what new knowledge is in the initial and later stages of development. It is therefore necessary when field days are organised at research stations to keep this in view and prepare information folder as well as take steps to show the research plots where new knowledge is being tested. While doing this the economic aspects should be pointed out in a very clear way.

2. New technology has to be tested under different agro-climatic zones in order to support the results of research obtained at research stations: No new research technology can be

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recommended for a particular agro-climatic zone unless it is specifically tested in the farmers fields of that zone. This is popularly known as conducting adaptive trials or district trials or trial demonstration work. Plans for such testing work have to be discussed during the field days conducted at research stations. Further a systematic programme of conducting trials should be discussed at the regional and/or district levels before two to three months of the start of each season in which research workers responsible for developing this new research technology participate actively with the extension staff of the University as well as the State Government Departments. It is also necessary to discuss these things in the state level as well as zonal level workshops or meetings like the package of practices meeting so as to invite useful reactions on the developed technology. In the area of operation of the extension education units of the University, the testing work will be conducted by the staff of the University Extension Units while in other areas this programme has to be implemented in collaboration with the staff of State Government Departments.

3. Results of adaptive trials should be carefully collected, analysed and presented alongwith the results of research obtained at research stations: Before the recommendation could be made for the transfer of research technology, this is a very important aspect of work which should be considered as a pre-requisite for the transfer of research technology to extension. In the absence of these local facts and their careful analysis, it will be rather difficult to recommend for the transfer of research technology to extension. This kind of information when analysed economically will help the concerned research scientists to develop confidence in the usefulness of the new research technology developed by them.

4. First stage or early demonstrations are necessary when the research technology has been newly recommended for extension: Although through adaptive trials and analysis of the results the research workers may have gained confidence, it

is necessary for field extension workers to develop this confidence by participating in the first stage or early demonstration programmes. So before a new research technology could be popularised on a campaign scale, it is essential that first stage or early demonstrations are conducted in the area where such campaigns have to be launched and field extension workers develop confidence in the new technology to be transferred.

5. Necessary arrangements for supplies of inputs like seeds, chemicals etc., must be made available before a new research technology could be transferred to extension through campaigns: Many times it is observed that wide publicity is given for the transfer of new research technology without making adequate arrangements for the supply of the needed inputs like the seeds, chemicals etc., when this happens it will slow down the rate of transfer of research technology to extension.

II. Linkages to be developed with the State Government Departments

The linkages between the University and the State Government Departments should be established through :

i) Participating of zonal scientists in regular distrist level meeting organised by the State Government Departments which ensures a continuous collaboration of research and extension.

ii) Regional and State Workshops should be organised seasonwise and yearly, respectively where the research programmes, field testing programmes and practices to be recommended should be discussed. The recommendations should be worked out after consideration of research data, environmental constraints, economic significance and risks.

iii) The University should invite the staff of the State Government Departments to participate in the University Crop Workshops for co-ordination of crop research and recommendations.

III. Procedure recommended for transfer of research technology to extension

1) The recommendations from regional or zonal workshops as to the extension and field testing programme should be submitted to the State workshops once a year.

2) The recommendations of the State workshop should then be placed before the Extension Education Council of the University for information as far as the programme of University extension services are concerned relating to the transfer of new research technology.

3) Taking into consideration, the recommendations of the Extension Education Council, the Director of Extension will approve the University extension programmes involving transfer of new research technology and communicate the same to the University field extension team for implementation.

4) Programmes relating to the work of State Government Departments will be finally approved by the Director of the State Government Department concerned before being passed on to their district and regional committees and staff for implementation of programmes relating to transfer of new research technology.

5) The State workshops would be informed of gaps in programmes of the University as well as the annual research programmes.

6) Assessment of research results in the field through testing programmes will be done continuously by the State Government Departments and the University field extension units which would inform the regional research personnel, the Departmental Heads of the University and Crop Co-ordinators about these findings.

7) It might be profitable to have exchange of personnel between the University and the State Government Departments particularly in respect of selected extension staff positions which would help in the process of transfer of research technology to extension.

Documentation and Maintenance of Research Information

R. Vijayamma*

1. General: The function of Research is essentially generation of new information, part of which is put to practical utilisation in due course. It is a fact that a large number of experiments both in the field and laboratory are conducted every year in the U.A.S., generating considerable data. The Technical worth of any research output, is best judged from relevant data it generates (quality as well as quantitywise) and the future use it is put to; and these in turn very often largely depends on the way, the scientific information is documented, indexed and periodically disseminated to the Scientific World for the consumption of Scientists who are working on similar projects. The data collected is therefore required to be brought together in an integrated manner, so that it could be retrieved whenever needed without much difficulty. The absence of such a store or a Data Bank leads to duplication of work and delay in the utilisation of results and subsequent analysis. In order to effectively check this situation, it is necessary to maintain a comprehensive information of Research conducted. This requires an efficient 'Information System', designed to match the increasing load in terms of speed, effectiveness, utility. timely and economy of functioning.

2. Research Information: Data Bank occupies the place of a library wherein the inflow and outflow of Research Information takes place. The available information is made use of, for research purposes. Consequent on the completion of the Experiment/Investigation, the results or the salient features which emerge, will enter into the Data Bank and will

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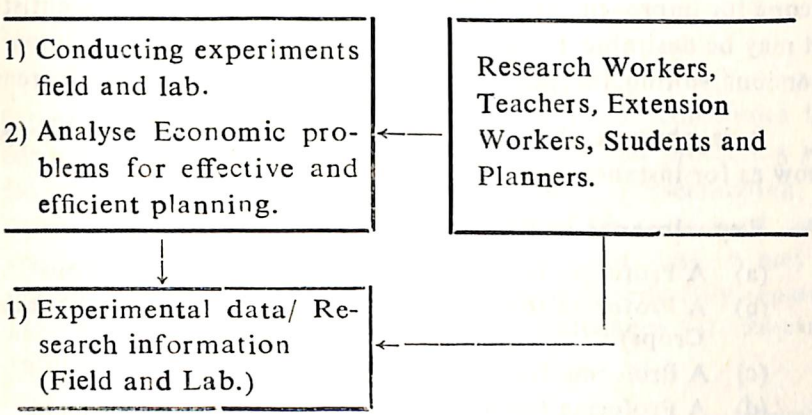
make the process a continuous one. Thus the volume of information accelerates and hence the need of storing the information in a systematic manner. The following diagrammatic presentation illustrates the flow of information into and outside Data Bank.


Data Bank
1) Conducting experiments field and lab.
2) Analyse Economic problems for effective and efficient planning.
Research Workers, Teachers, Extension Workers, Students and Planners.
1) Experimental data/ Research information (Field and Lab.)

3. Basic Information and its Generation: This refers to the basic information of Scientific texture generated by careful documentation of observations recorded on every research project carried out in the University from time to time. Prior to this stage, a lot of technical expertise and scientific conceptulization would have fully matured before the execution of the research project.

The uniformity of data as to the adequacy of quality and quantity can hardly be over emphasised, while recording observation pertaining to any experiment. It is not uncommon to meet with a scientist who might think that spectacular and significant results could be produced by 'suitable' statistical manipulations of his data, whatever its defects may be. For such misconceptions, we are often reminded of an acronym. 'GIGO' which means 'Garbage in (leads only to) Garbage out'. Thus, we should ensure adequacy of the quality and quantity of this basic information. For this, there is an immediate need

for systematization in procedures for recording, documenting and processing of scientific data before disseminating the same to the world of scientific workers.

Periodic instructions have been issued (in the past) by the Directorate of Research, towards this end, resulting in some format for recovery of observations. Since there is always scope for improvement, born out of experience of our scientists, it may be desirable to take another look and develop improved versions suiting the present and future needs of research areas.

It is obvious that several proformas are to be developed now as for instance—

A. Experiments in Plant Sciences :

(a) A Proforma for Field Experiments : Annual Crops
(b) A Proforma for Long term field experiments : (Annual Crops)
(c) A Proforma for Perennial experiments
(d) A Proforma for green house/pot culture experiment
(e) A Proforma for Lab. experiments
(f) Special formats not covered in the above.

B. Experiments in Social Sciences :

(a) A Proforma for studies in extension education
(b) A Proforma for social sciences

C. Experiments in Veterinary, Animal and Poultry Sciences :

(a) A Proforma for clinical trials
(b) A Proforma for animal genetic experiments
(c) A Proforma for large scale experiments of survey types (as in public health survey).
(d) A Proforma for laboratory experiments.

D. Experiments in Fisheries Sciences :

Suitable proforma on the above lines.

Once these proformas are developed, they will have to be

filled-in for each approved research project carried out by the scientific personnel and submitted to the Directorate of Research, for further processing *viz.*, Documenting, Indexing, Scientific Processing and Disseminating to the benefit of Research Workers of UAS, the last being taken up with care and caution. If the Scientist has any restriction on this count, for a valid reason, the release can be withheld until necessary.

4. Data Bank: The proforma completed in all respects for each approved research project/experiment constitutes the fundamental source of information for further processing *viz.* Documenting, Indexing, Processing and Disseminating of Scientific Information. Since each can be considered as a specialized area of activity over a period of time, it may be useful to conceive of the DATA BANK as functionally separate as: 1) Documentation and (ii) Maintenance of Research Information.

(i) **Documentation:** concerns mainly with maintenance of basic data through scrutiny, for the accuracy and completeness of the information entered in the proforma in respect of every research project in the UAS.

The information may be recast in a form which facilitates its transmission to punched cards (or to computer tapes or discs, if necessary at a future date) for permanent storage as an ever lasting source of information. This facilitates retrieval of information whenever required.

If transmission to computer cards is not envisaged right now, still the Documentation may confine to storage of information and its retrieval in the conventional file forms plus the following.

Develop Indexing and Cross-Indexing cards to facilitate location of information by cropwise, diseasewise, agronomic and cultural practice-wise etc.,

Index Card: These index cards (of standard size as used in libraries) may be arranged alphabetically, according to cropwise (major and subdivision with) the major, as per library documentation principles indicating cross references to all the folders which contain abstracted information in summary forms, culled out from the respective main proforma forms.

This will facilitate the information seeker to retrieve all relevant information on that crop available from all relevant research projects for which the crop is main. Furthermore, if the indexing when done to facilitate location of the source by disciplinewise, for example, Pathology, Entomology, Microbiology, Soil Science, etc., will be of much use to the information seeker. If the information seeker is interested only on every thing pertaining to Pathology part of information cards will help him to identify all references about the projects emphasizing the Pathology aspects on that specific crop.

Thus, the Documentation is a critical activity since it leads to the formation of an official Custodian of all documents, pertaining to the research projects of the University. The Documentation Unit besides documenting it, in varied forms, render help to the information seeker etc.

(i) **A brief note about Codification of Research Project– Research Project Numbering System** with a statement of Department Code letters allocated to various departments in respect of UAS support Research Projects is given in the Annexure.

(ii) **Maintenance of Research Information** concerns with consolidating the information after processing the same, by employing suitable statistical methods of analysis etc., and disseminating the necessary and relevant information of research, which are of value to Scientific World. Some of the functions may be detailed as follows :

(a) Wherever it is necessary, the analysis of data of every experiment may be completed and the information is

abstracted, entered in specially prepared proforma and indexed for reference use.

(b) In the case of multilocational trials, the analysis is carried out and the consolidated information is prepared, entered in proforma and indexed for reference use.

(c) In the case of fertilizer and other trials which are carried out by many scientists independently, the information on treatment effects etc., over time and space may be updated.

(d) Based on the Research outcome on completed projects, the highlights of the results may be culled out and short bulletins giving more relevant information, circulated within the UAS for the benefit of the Scientists who may either be working on similar projects or who may plan project on similar lines.

This periodic communication will not only prevent wasteful duplication of work but will help to plan the subsequent research projects in a more result-oriented way.

(e) May prepare information-oriented charts, graphs and diagrams highlighting all important (confirmed) results for the benefit of research workers, display purposes etc. outside the UAS for the benefit of planning our own research projects.

Thus, it is hoped Data Bank with its varied activities of documentation, indexing, processing and dissemination of scientific information, will make an important contribution for better research in UAS.

Codification of Research Project – Research Project Numbering System

To identify a Research Project it is essential to give a code number. This would not only give distinct identification of a particular research information but would also help in retrieving the information either manually or by machine, using a computer. Codification helps, monitoring periodically the progress of the work in physical and financial terms. At present there are various types of research being carried out in the field of Agricultural Sciences in UAS. There are long term multidisciplinary All India Co-ordinated projects which are 35 in number on various crops/subject matter, some of them conducting multilocational trials. Besides, short term ad-hoc projects which are supported by outside agencies like Government of India, Government of Karnataka, KDDC, UGC, BARC, KSCST, PL-480, I.M.D., SBI, IASRI, Harihar Polyfibre etc. are also being operated by UAS. There are about 400 well formulated problem oriented research projects financed by UAS budget. In addition, collaborative research with other institutions is also going on. It is noteworthy that PL–480 authorities have come forward to revive assistance to UAS and about 90 project proposals have already been submitted by the scientists which are under active consideration. Looking at the problem of nature and types of research projects, a coding system for the research projects has been developed at the Directorate of Research for its identification and retrieval.

1. DR Number — Will be assigned by the Director of Research.

2. The project number portion of the Code, given below, to be maintained and at quoted at the Departmental level, will be the same as the one assigned by the Director of Research. All the experiments taken up under an approved research project, will

continue to be serially numbered and expressed as a decimal number of the project number separately for each department. Any new experiment added during the operation period of the project, will have a continuation serial decimal number.

Code number of the Project/Experiment will be

DR	CRP or Adhoc or UAS Funded project	Department (Code letter)	Project Number and Experiment Number	Year of Research council in which the project is approved

ANNEXURE

Statement of Department code letters allocated to various departments in respect of UAS support research projects.

Name of the Department	*Department code letters*
1	2
Agricultural Sciences	
1. Agronomy	AGR
2. Agricultural Engineering	AEG
3. Agricultural Microbiology	AMB
4. Agricultural Botany	ABT
5. Agricultural Chemistry and Soils	ACS
6. Agricultural Entomology	AEN
7. Agricultural Extension	AEX
8. Horticulture	HT
9. Seed Technology	STH
10. Plant Pathology	PP
11. Crop Physiology	CP

1		2
12.	Agricultural Economics	AEC
13.	Agricultural Marketing and Co-operation	AMC
14.	Farm Forestry	FF
15.	Home Science	HS
Basic Sciences and Humanities		
16.	Statistics	ST
17.	Bio-Chemistry	BC
18.	Mathematics	MA
19.	Physics	PH
20.	Chemistry	CH
21.	Sociology and Economics	SE
22.	Psychology	PY
23.	Botany	BT
24.	Zoology	ZL
25.	Microbiology	MB
Veterinary Sciences		
26.	Veterinary Anatomy	VA
27.	Veterinary Pathology	VPT
28.	Veterinary Parasitology	VPR
29.	Veterinary Physiology	VPY
30.	Veterinary Pharmacology	VPM
31.	Veterinary Medicine	VMC
32.	Veterinary Surgery	VS
33.	Veterinary Gynaecology and Obstetrics	VGO
34.	Veterinary Microbiology	VMB
Animal Sciences		
35.	Animal Genetics and Breeding	AGB
36.	Animal Nutrition, Management and Production Technology	ANM
37.	Poultry Science	PS
38.	Dairy Technology	DT

1	2
Fishery Sciences	
39. Aquaculture	AQ
40. Fish Biology	FB
41. Fishery Hydrography	FH
42. Fishery Processing Technology	FPT
43. Fishery Engineering	FEG
44. Fishery Economics	FE
45. Fishery Microbiology	FMB
46. Fishery Biochemistry	FBC
Others	
47. Kannada	KA

Problems of Research Management of the University of Agricultural Sciences

H. P. Achar[1] and S. N. Kadapa[2]

The University of Agricultural Sciences formulated in 1965 has accepted the responsibility of teaching, research and extension education in Agricultural Sciences in Karnataka State. The responsibility of these three assignments has been increasing year by year and the University has passed through a decade plus two years in this direction. It is but natural that a stage has come to take stock of the situation to further plan and develop the research activities, in particular, on more varied, effective and useful basis.

The problem of research management involves different phases of management control *i.e.*,

1. Programming
2. Budgeting (Standards)
3. Accounting
4. Reporting and Analysis

All the four phases of management-control must be continuous and complementary, so that a cogent picture of research management is evolved. In each one of the above phases, the following entities are involved which are a part and parcel of the management. They are :

1. People
2. Organisation
3. Resources
4. External factors and
5. Decisions

1. Associate Director of Agriculture, Directorate of Research UAS, G.K.V.K.
2. Chief Scientific Officer (Plant Science), College of Agriculture, Dharwad.

I. Programme management

The people involved in the programming must be actual research workers and should possess devotional interest to that programme. All facilities and atmosphere should be created for creative thinking and programming such that the tempo of the creativity is maintained throughout the execution of the programme without interference of the other external factors of administrative nature. The people involved in the programming should work within the frame work of the organisation but at the same time constraints in resources should not be felt. The programmes once planned should be based upon the suitable personnel resources available and interest in the particular aspect of research involved. External factors should in no way discourage or hinder the proper implementation of the planned programme. The work load for the research workers should be so planned that there is no fissiparous tendency of the energies of the research workers other than for what they are meant for. No doubt the research workers should be encouraged to improve upon their knowledge and also to keep themselves abreast with the progress of science but at the same time the programme should be such that they are encouraged to do other activities without detriment to their legitimate duty.

The programming of research management should involve the operational research programmes, which are now becoming a full component of the research programme. The personnel should be so organised and set up that enough scope is available for implementing such programmes. The research workers should be encouraged to develop new project or programmes which will not only further their technical competency but also will keep the University in a continued state of progress. The research workers should also have opportunities for obtaining regular training in advanced research techniques and decision making, involving problems of their interest. The programme of scheduling should be such that the programmer should have enough lee-way either to include, modify or delete the programme, even though it has been decided earlier.

The staffing pattern for organisation of the research programme should be such that not much of time-gap is left between the proposal and proper execution of the same and also between the execution and full development of the programme.

It may be better to prepare panel of personnel in advance, either discipline-wise or cadre-wise, so that the schemes or programmes when approved may be straight-way implemented without an avoidable delay.

Evaluation of research workers must be a periodical one. For the same a sort of promotional or encouragement opportunities must be given, eventhough regular or better posts may not be available to the research workers. This will also encourage them to continue in their research work with interest and devotion, without looking for promotional aspects at the cost and jeopardy of the research project.

The redistribution of research personnel within or among the different programmes should be a need-based situation and no water tight compartments need be made. It is needless to state that the results of research and their adoption at large by the farmers should form the basic criterion for development of research programmes in the University. The UAS has been and is recognised to a large extent, by the public for its useful and far-reaching results in crop improvement and crop production. Therefore, a more suitable status need be given for planning and development of research programmes on sound and long-term basis in the larger interest of farming community.

In the implementation of research programme, the UAS farms have to play an overall and significant role. In this process of research management, the main factors to be considered include separate sub-organisation of research activities and other activities like seed production, training programmes, farm development and extension activities of the farm.

There seems to be an immediate necessity to develop suitable labour and production norms for different activities of the farm with respect to money and man power. The norms so developed should invariably form a flexible tool for successful farm management under normal and abnormal seasonal and environmental conditions.

There may be a high level research sub-committee for each agroclimatic zone, established and charged with the responsibilities of development and management of the research station in all its perspective. The sub-committee will be in turn responsible for the UAS.

Budgeting and accounting

The programme so planned should be subject to a review committee which should decide and finalise the budgeting of the programme. When once the budget is finalised, the programmer should be given the full authority to implement the project or the programme under certain guidelines as are common in the UAS. Further, certain adjustments within the budget must be allowed and decisions taken by the programmer himself without involving the circuitous procedure. Moreover, such kind of deviations or alterations in the programme of budget should be subject to periodical reviews by the review committee which is meant only for successful execution of such programmes. Accounting procedures within the budget must be simplified such that the programmer will be able to secure or procure the necessities for both scientific equipment as well as for the day-to-day requirements of the project. Inordinate delays experienced, may require to be set right with some alterations of the present procedures. Budget utilisation by the programmer should be such that no other external factors are involved in spending the amount without the knowledge of the programmer.

Reporting and analysis

The present system of reporting and analysis may be continued. The procedures for publication of research papers

and other publications need to be streamlined and the actual worker/s should be encouraged in this direction.

The ideas presented in this paper will, it is hoped, generate discussions that lead to finding solutions to some of the aspects so as to make the research management more effective.

Inaugural Session

Dr. K. Krishnamurthy, Director of Research welcoming the participants, said that the objective of the seminar was to review and improve the research system. He further said that this was the first occasion such a meeting was held and expressed the hope that it would go a long way in solving the problems and improving the reaearch system.

Opening remarks by the Vice-Chancellor

The Vice-Chancellor said he was happy to have an opportunity of meeting together for a review of the research work that is being done from time to time. He said, it was necessary in order to get an idea of what is going on at present and what requires to be done in future.

The research in the University is not pursued for its own sake or merely for pleasure. In performing this function, we are accountable internally and externally. Internally, every research worker should work to the satisfaction of his controlling officer as well as to the Director of Research apart from the Board of Regents. Externally, we have several State Development Departments, State Government, Farm Leaders and the Farming community to be satisfied. In addition, we have the ICAR who provide a substantial part of our funds to be taken into account.

The Vice-Chancellor was happy that the University had earned for itself a reputation at the National level. Research has made its contribution for this position. We have made several contributions not only of value within the State but also at the national level. All the same, we have certain areas which needs to be looked into in our research system.

In identifying our problems for research, we have to have a perspective of what is happening within the State and elsewhere

and take note of the burning problems of the day, or of the near future. Therefore, goal-setting in research is a very important step, which so far has been done only up to a degree of satisfaction. Improvements are possible.

After setting the goals, we have to develop and conduct research programmes in a systematic manner which may be called as an effort towards goal achievement. Even here, while we have done something good, a lot more remains to be done.

Research is often pursued as though it is an endless task. While research as such is endless, research tasks could have a time dimension. This aspect of conceiving our research programmes as time bound needs greater emphasis in future.

Apart from the above, there are some other aspects that require our urgent consideration. when a research project is formulated, certain financial resources as well as man-power is allocated for conducting these activities. But, in handling the research finances, we seem to be lacking in the financial rigours. On one hand, we do not apply the rules and regulations in existence and on the other even the commonsense principles sometimes are not brought into play. While this is very undesirable, it is quite possible that somebody may be hurt very seriously, if this deficiency is not remedied forthwith. This applies even to the utilisation of the personnel that are allocated to the research projects in distribution of work, providing effective supervision and control. We seem to be taking matters somewhat easy. Even in respect of facilities, made available for research like transport are not being used with adequate care in some cases. It should not be forgotten that all these resources – men, material and money are public resources and we have an opportunity to use them for a particular purpose under a particular set of norms. The researchers would not be an exception to the operation of the rules and regulations in this regard.

Lastly, the Vice-Chancellor mentioned that it is to be acknowledged that a substantial amount of good work has been

done on our research system so far. Further, there is plenty of scope for improvement in our attitudes and approaches to our research work, as well as in our managerial competence at different levels. It is hoped that we would be able to give the necessary attention to these matters in the course of our two-day deliberations.

Session I

Chairman
Dr. R. DWARAKINATH
Vice-Chancellor

Highlights of Research and short-comings

Session–I was chaired by the Vice-Chancellor in which the highlights of research and short-comings in the fields of agriculture, home science, veterinary, fisheries and basic science were presented by the concerned Directors of Instruction.

Dr. S. V. Patil, highlighting the research work in the area of agriculture said that research should be relevant to the needs of the agricultural development. He said, research is not to be carried for others sake, but there should be individual initiative and responsibility. He further said the opportunity for the self improvement should be provided, there should be grater involvement on the part of the scientist and there should be evaluation for all kinds of scientists. He stressed the need for the preparation of a manual detailing the decentralisation of technical, financial and administrative work and preparation of job chart for each scientist. He also pointed out that working arrangements with Government Departments and other institutions and research organisations for carrying out collaborative research work should be attended to and a standing committee should be organised to take care of such work.

Dr. (Miss) Meera Rao, highlighted the research work in the area of Home Science and said adequate knowledge to rural

women in farming practices is essential. She said research in rural Home Science can be of two types (i) Home Science by itself and (ii) Interdisciplinary programmes with other agricultural subjects. She stated that communication procedures and policies for research proposals needs to be improved. She also mentioned that we should have a policy for giving seminars by the scientists who attend All India Seminars, so that the knowledge is shared by other scientists.

Dr. K. Trivikrama Rao, presented briefly the research work carried out in the area of veterinary sciences and said that there is need for the establishment of a composite livestock farm in the University to take up research programmes in animal production on the lines similar to those of research stations to individual crops. He also stressed the need for an experimental house in the veterinary college to take up any research programme of animal health coverage and for the establishment of (i) Department of Meat Science and Technology (ii) Department of Toxicology. Expansion of small animal house, Setting up of a common instrumentation section for proper maintenance and repairs and to be used by others also who actually need and a simplified procedure for the animal feed purchase in order to increase the efficiency of the farm was suggested.

Prof. H. P. C. Shetty, highlighted the research work in the field of Fisheries Science and narrated the difficulties involved, in testing the encouraging results obtained from the composite fish culture in smaller water bodies, onto larger water bodies for want of big fish pond. He also stated no work has been carried out in the areas of Brackish water culture and Mari culture and craft technology and gear technology for lack of requisite facilities and trained personnel. He stressed the need for expansion and intensification of designing and fabrication of new equipments to serve as import substitutes and for setting up of a suitably equipped workshop. As regards sanction to the research projects, he said, budgeting should be done at the time of approving the research project proposals in the

Research Council itself, so that the research workers can plan their work properly. He requested the University to finance the projects which are quite expensive to operate in view of the fabrication of the costly equipments, when it is not possible to involve any other funding agency for financing. He suggested constitution of separate research project Screening Committee for each campus to avoid delays and work out plans to get the staff trained abroad for planning and implementing effective research programmes.

Dr. R. Narayana, highlighted the results in the area of basic sciences and humanities and emphasised the need for Research Assistants in Basic Sciences and budget allotment for different Departments of Basic Sciences and also the grants to be liberalised.

Session II

Chairman
Dr. R. DWARAKINATH
Vice-Chancellor

Panel discussion on the short-comings of Research

Elaborating on the above papers, the Vice-Chancellor expressed their importance in the State of the present position in research activities of the UAS and said that this would serve as a beginning for future deliberations in future seminars on research management which should be held more frequently.

Several participants including Mr. Mallanna, Dr. K. S. Krishna Sastry, Mr. R. Krishnappa, Dr. R. Narayana, Dr. U. V. Sulladmath, Dr. T. S. Thontadarya and others indicated the problems faced in the management of either ICAR (Adhoc and Coordinated) or UAS research projects/schemes. Some of the important issues brought out during discussions were:

1. Lack of inter-disciplinary approach in the co-ordinated research programme.

2. Use of research personnel by Heads of the Departments, for teaching to some extent at the cost of research work which is the legitimate duty of the scheme staff.
3. Lack of coordination between ICAR and UAS project personnel in the smooth implementation of the respective projects.
4. The relationship between ICAR Co-ordinator and the UAS Head of the Department, not clearly specified.
5. Lack of adequate facilities such as Labs, land, irrigation, watch and ward and non-protection of the experimental area by proper fencing.
6. Inadequacy of staff to handle the research projects due to non-filling up of the posts in time, especially in Adhoc, ICAR and other schemes.

The Vice-Chancellor while agreeing with some of the above problems felt, lack of irrigation facilities is no doubt a serious problem than even the land problem and felt that some steps could be taken in improving this. He also suggested that Mr. Mallanna should concentrate on ragi at Chintamani or at Mandya and not at Hebbal/GKVK. The work on minor millets can be carried out at the UAS Campus, Hebbal/GKVK.

The Registrar suggested that instead of concentrating various schemes/projects either at Bangalore or at Dharwad, they can be located at other places subject to availability of facilities and personnel.

Dr. K. S. Krishnasastry, further pointed out that in case of Adhoc, ICAR research projects, it is sanctioned for a person rather than a place and this should be borne in mind. He further stated that operation of Ad-hoc projects suffer greatly due to non-filling up of the posts in time, and therefore the need to fill up the posts early, if necessary by following a simplified procedure.

The Director of Instruction (BS & H) cautioned that the water at Hebbal tank is already getting polluted. He further

added that shortly the catchment area also is going to be used for construction of housing colonies which would totally upset the irrigation facilities at Hebbal. He called for immediate action in this regard. The Vice-Chancellor suggested to use sub-soil water and felt that some serious action in this direction is over due.

Dr. Gururaj Hunsigi expressed that of late diversified cropping has been taken up at Sankeshwar station instead of concentrating on sugarcane. The Vice-Chancellor felt that the diversification was needed since the work on sugarcane was not up to the mark. Both Dr. Hunsigi and Dr. Kadapa expressed the immediate need for providing irrigation facilities since this has come in the way of satisfactory execution of the research programme.

The Director of Research, commenting on the working of the Sankeshwar Research Station, clarified that as per the NARP programme, Sankeshwar has been recognised for sugarcane work. He also assured to fill up the vacancies as early as possible.

Prof. Ramaiah enumeraling the work done in his Department expressed that one of the reasons for certain shortcomings in the working of the Department was due to unequal importance given to the different Departments. He pointed out that there is always a request by various Departments of the Dharwad campus to attend to minor repairs of the farm and other machineries used by them, and it cannot be met on account of non-availability of staff like Mechanic, Carpenter and Helper. He further stated that the tractors are at present kept under the control of the Farm Superintendent, while servicing is attended to, by his department. He suggested that the complete control of tractors and other machineries should be with his department for better technical management. The Vice-Chancellor agreed for the transfer of tractors and other mechineries and assured to provide necessary posts to set up a workshop.

Prof. K. R. Kulkarni, pointed out the following constraints in the execution of research projects:

1. Incurring of the expenditure on the schemes by drawing officers (Farm Superintendents), without the knowledge of the scheme head.
2. Transfer of staff of the schemes/projects, without the knowledge of the concerned project/scheme head.
3. Entrusting the staff borne on the scheme/projects, with the works other than the project work.
4. Lack of interdisciplinary coordination among the scientists of coordinated projects.
5. Decentralisation of financial and administrative powers.
6. Delay in getting replies from UAS, on the problems raised research scientists.

The Vice-Chancellor, while agreeing with some of the points raised, said that decentralisation is possible only when the responsibility is discharged satisfactorily.

Dr. M. A. Singlachar brought out two major issues: (1) Difficulties faced by crop coordinator in smooth execution of scheme work when the schemes are manned by Scientists of the same rank and hence the need for their duties to be spelt out and (2) Type of administrative structure for a good research work.

Dr. G. Shivashankar, while referring to this difficulty suggested that cases where there are equal ranks, one of the posts could be upgraded.

Dr. K. S. Krishnasastry, agreed on the lack of coordination and interdisciplinary approach in the coordinated schemes and suggested for the reorganisation of the Department, to overcome the overlapping of research programmes. He further suggested that Department of Plant Nutrition may be formed by involving persons from the Departments of Chemistry, Crop Physiology and Agronomy. Prof. Venkata Rao suggested that any work of project/scheme can be smoothly carried out only if the people concerned give significance to work, rather than personalities involved.

Dr. A. S. Hadimani suggested that scientists of the Coordinated schemes should consider and tackle regional problems as a part of their scheme work. He stressed the need for the establishment of seed production units in each Regional Research Stations and also for their strengthening.

Certain general points were also discussed particularly on the issue of raising coconut seedlings in various UAS farms. The Administrative Officer suggested that procurement of seed coconuts is hampered this year since the UAS agreed to pay procurement price of 10 per cent higher than the regulated market rate and suggested that looking to the quality of the seed nuts being procured by UAS, this could be raised to 20 per cent. The Director of Research said that the Board has taken decision to pay only 10 per cent as the State Department of Horticulture is presently paying only 10 per cent and expressed that it may not be desirable to increase further. The Vice-Chancellor emphasising the importance of this work suggested to the Director of Research to use his good offices with the Director of Horticulture and convince him about the need for paying 20 per cent.

The Vice-Chancellor further asked all the Chief Scientific Officers to express their view points on the research management problems.

Dr. Katarki said that (1) the integration of research, teaching and extension is to be re-examined and the integration should not be at the cost of the scheme work ; (2) the crop team should be strengthened and all the workers should be responsible to the crop leader ; (3) Fundamental problems should be tackled by teachers with a good understanding among themselves ; (4) the services and supplies are inadequate and untimely ; (5) The foundation seed production should not be at the cost of breeders seed production ; (6) Importance to be given to the active research and operational research; and (7) Expansion of Directorate of Research for effective functioning since at present

it is handling various disciplines like Agriculture, Animal Science, Fisheries Science, Home Science and Basic Science etc.

Dr. Hanumanthappa, said professional ethics is important and personal sacrifice is needed for effective attitudal change, which is also required to acquire knowledge. Human relations and skills will have to be practised so that nobody is affended, but helped to get along well with others.

Dr. Uttappa, mentioned lack of staff, procedural delays and difficulties in the purchase of materials through Stores Purchase Officer and the problems in handling the finance through Sr. Farm Superintendent. He further emphasised the need for starting of livestock farms for upgrading the research in Animal Sciences. He also said culled animals should not be sent to different research stations and emphasised the need for six working days a week.

Dr. A. V. Rai, further elaborated the need for starting of the livestock farm and suggested that animals should not be placed at stations where Animal Scientists are not available. He suggested for a simplified procedure for the purchase of feed for animals in the University. Dr. S. N. Kadapa mentioned that the Government has sanctioned acquisition of 80 acres of land in Gadag but could not be acquired due to non-availability of funds. He brought out the need for the irrigational facilities for sugarcane research at ARS, Sankeshwar.

Dr. B. S. Keshavamurthy, commented on aptitude for research and suggested that as is in vogue in foreign countries, the personnel to be included in the collaborative research should be first selected and also their suitability assessed for smooth working of the research programme. He suggested that the staff appointed in the ad-hoc schemes should not be disturbed in the middle. He pointed out the need for better rapport between the UAS Department of Animal Science and that of State Department.

Dr. H. P. Achar, mentioned that the scheme Head is not able to function efficiently because of lack of coordination between the scientists working in the scheme and the Head of the Department. This view point was supported by Prof. K. R. Kulkarni. He also said some ICAR projects deal only with the applied aspect of research like field work, statistical work and laboratory work. As such the concerned Departments should deal with the fundamental problems which are not dealt within the coordinated projects.

Mr. Chandrasekhar Buggi, felt that the real problem in the efficient management of research is the management of human relations rather than other factors. The Vice-Chancellor suggested Mr. Buggi to study the working of one or two coordinated projects, so as to bring to light, the real reasons for the present problems in the execution.

Mr. B. J. Nanjundappa said that the trend of discussion show the gap in respect of communication and coordination. He also suggested that a committee involving some Directors of Instruction, Chief Scientific Officers and Coordinators with the Technical Assistant to Director of Research as convenor may be formed which can assess and suggest the remedies for the problems in the management of research.

The Vice-Chancellor while summing up the discussions of Session–II suggested that for the smooth working of the research programmes it is the spirit and zeal of a worker that accounts rather than the bottlenecks, either on the technical or managerial problems. The control of a project would rest with either the Head of the Department or the Coordinator depending upon the nature and the need of the project and this has to be kept in view for smooth operations. He also clarified that the actual staff working at the scheme are primarily and administratively responsible to the Coordinator who would be responsible in the proper execution of the project work, while the Head of the Department will be responsible for the technical functioning of

the project. He requested the Director of Research to examine the various pros and cons of these problems and come out with suitable suggestions in a short time.

Session III

Chairman
Dr. N. G. Perur
D. I. (Agri.), B'lore.

Panel discussions on the topics

1. Professor B. V. Venkata Rao, presenting his paper on Philosophy of Research, defined fundamentals of scientific methodology which inculcate an objective attitude to problems and their solutions. He stressed that dedication, spirit of selflessness and attitude to work, honest coordinated pursuit of the programme of work and job satisfaction are the cardinal points that contribute to productive research more than positions, associated salaries and such other material considerations.

Mr. Chandrasekhara Buggi, said that the Philosophy of research should include in addition to the dedication of the researcher his attitude and obligation to the Society.

The Vice-Chancellor said that the University should generate knowledge and technology which is useful to the people who practice agriculture, specially those of the State of Karnataka and ultimately the country and others. He also further elaborated that the State Government and the people are financially supporting the University. As scientists we have, therefore, a primary responsibility basic duty bound and moral bound to help them to carry out their programmes. Scientists, being different from others, are entrusted with the responsibility of maintaining the integrity of research.

Dr. B. Krishnamurthy, said philosophy is to create, creativity of research. The type of supervision may lead to

productivity but may also curb individual creativity and in the long run the supervision may not lead to better productivity of individual scientist.

Dr. H. P. Achar, presented a paper highlighting problems of research management in the UAS. He said in programme management, people involved should be devoted to the work, involve with operational research programme to help farmers. The research worker should have training in research management and the programmes should have flexibility. He suggested for high level research committees for each agro-climatic zones, established and charged with the responsibility of development and management of the research stations in all its perspective. Budgeting and accounting should be done properly by the programmer and the procedure simplified. The procedure for the publication of results of research need to be streamlined.

Mr. Raghumurthy suggested to take up seed production programme in most of the farms as all the area in most of the stations is not put under experiment. He also suggested that the Crop Planning Committee has to thoroughly examine the situation existing and plan the programme accordingly. He stressed the need for maintaining records of expenditure incurred for experiments conducted on the research farms.

Dr. K. Krishnamurthy, suggested that in the yearly work plan names of all the scientists involved should be mentioned and this will serve as a basis for including the names of co-authors in the papers to be published. He also presented the Directory of the concluded projects and on going projects based on earlier discussions. He requested to send the conclusion report for all the concluded projects in the prescribed proforma.

Dr. A. S. Hadimani, commented that lot of time was spent by the research workers on seed production. He suggested that the first priority should be given to research and second priority may be given to seed production.

Replying to Dr. Hadimani's comment, the Vice-Chancellor said that although our scientists are selected for specific jobs, they should be able to manage multiple activities, on a research farm rather than restricting to one single activity.

Dr. K. A. Jalihal, further added that scientists should not be static but should be dynamic and prove equal to the changing requirements and willingly take up more and more responsibilities.

Dr. G. Shivashankar, said that all the crops grown in the State have not been taken up by the ICAR and as such he wanted that University to take up research on crops of local importance.

Prof. K. R. Kulkarni, explained the various types of funding in different ICAR Schemes. The Vice-Chancellor said that because of the limited resource with the University and failure to generate more funds from within the University, it may not be possible to allocate all the money required for research. Depending upon the financial position of the University, funds will be provided for research purposes.

Mr. H. M. Nagabhushana, informed about the improper budgeting, expenditure and receipts of the University. He said there is dearth of finance in ICAR Projects. There is lot of demand for ORC. The amount provided for should be allocated over all the seasons for efficient work, and no reappropriation is possible from establishment to other Heads. He requested every scientist to be careful in putting up the demands.

Dr. K. Krishnamurthy, presented a paper on problem identification. He emphasised the imperative need for selection of the right problem and the problems which are of immediate relevance to the farming community.

Dr. K. S. Krishna Sastry, commented that in the University no proper *modus operandi* has been developed for identification of problems. He suggested constitution of a committee which can identify problems of state/country and fix up priorities.

The Vice-Chancellor informed that Dr. Sheath (U.S.A.I.D. Consultant) had developed a procedure for submission of projects which has not been followed. He further said that there are two types of research problems, which may be envisaged namely, (1) fundamental and (2) applied. The fundamental problem is of academic nature and each individual scientist can identify such problems and pursue. As far applied aspects are concerned, he felt that though several problems were identified by the Department of Agriculture and suggested to the University, many of them have not been taken up by the University Scientists for instance study on lime application in Malnad, jowar work in Bijapur, work on ratoon crop in jowar have not been attempted.

Dr. Jalihal, suggested to have a separate session during the Krishi-melas for discussion on the feed back of problems from farmers. He also suggested that field-days can also be utilised for the identification of problems. Similarly, the District Level Training Programmes may be utilised for this purpose.

Dr. G. Shivashankar suggested that University may take up work on horsegram, mesta and mulberry.

Dr. K. S. Krishnasastry, presented a paper on processing of the project proposals for UAS and outside agency for funding. Based on his experience as a member of the screening committee he emphasised the importance of review of literature on the subject and detailing the competence of the scientists. He cautioned that requirements of the different funding agencies are not similar. Dr. Devaraj Urs, narrated his experience in sending an ad-hoc project on Chemosterilants. Dr. Krishnamurthy, suggested a thorough discussion with the other scientists and associates on the proposed projects, before they are sent for screening. Dr. Narayana, suggested utilising library facilities effectively for the preparation of bibliography of research on specific subjects. Dr. Havanagi, explained the details as to how the projects are approved/rejected at ICAR level, only after

a very rigid screening. He also told that higher percentage of research projects proposed by U.A.S. were approved.

Dr. Havanagi and Dr. Sunder Raj, presented papers on techniques for Agricultural Research and Conduct of the experiments, experimental designs, and recording observations. Dr. H. P. Achar, suggested orientation training to the research personnel in the University, and he also requested to suggest ways and means of statistical analysis of data when there are partial destruction of the experiments. Dr. Sunder Raj, stated that training is possible and requested the University to provide funds for deputing research personnel. Further, he stated that he would consider the suggestion of Dr. Achar and think of the ways and means of analysis of the data when some discrepancies are introduced in the experiments. He also said that in place of Duncan multiple range test, there are other better tests which can be used.

Mrs. Vijayamma presented a paper on Documentation and Maintenance of Research Information. She highlighted modern techniques of documenting the experimental results and research information. The new coding system for projects in the UAS was circulated to follow.

Dr. K. A. Jalihal, presented the paper on transfer of research technology to extension and linkages to be developed, with the State Government Departments. He pointed out that only the relevant information about the technology to go to the field. He dealt with the several stages involved in the transfer of technology and the linkages to be developed with the State Government Departments. He emphasised the importance of the scientists participation in the field days, and involvement in demonstration plots.

Mr. Mallanna, suggested the need to identify stations on Zonal basis for particular crop research. Prof. K. R. Kulkarni requested for the definition of the role of subject matter specialist in Extension Directorate. Dr. N. G. Perur said that

scientist who has evolved the technology should participate in the first stage of demonstration. Dr. S. V. Patil mentioned that only the varieties released are going out but the practices are not followed. Dr. G. Shivashankar stated that the variety Indaf–5 is good but it has not been pushed well to the field.

Finally the Chairman of the session summarised and stated that extension work begins where research ends, researchman generates the knowledge and extension man applies, but there is a common border. Some tasks could be performed by both. Research information is an element in technology. Subject matter specialists in Extension Unit can serve better.

Session IV

Chairman
Dr. R. DWARAKINATH
Vice-Chancellor

Panel Discussion on Administration and Management Components

The Director of Research said that the research programme must be problem oriented, region oriented and should be of practical use. He stated that each experiment costs lot of money to University. He added that at some places for a single person, a large number of experiments are allotted, which is rather a difficult job for a single person to handle. He added that any experiment without D. R. Number becomes unauthorised research work. Besides, the experimental records, the research worker should maintain experimental produce register for having handed over the material to the store. When the experiments are concluded, the conclusion reports should be sent to the Director of Research. If the experiments are not concluded they may be shifted on to the related All India Co-ordinated projects. The annual report should contain the technical programme, cropping plan, articles

the appointment and the situation is being remedied. He assured to provide a manual on job description.

The Registrar, appealed for the development of proper environment in the University for smooth functioning of the administration. He also appeared for personal approach for solving the problems of the University, without any barriers or reservation for smooth administration of the University.

The Estate Officer promised to help the scientists to the best of his abilities. He stated that under the existing financial constraints, he is trying his best for providing physical facilities like lab, construction, irrigation facilities, residential quarters and other farm development works. He also requested the scientists that whenever they place the indents, it should contain full particulars of their requirements. However, he assured for speedy action for purchasing chemicals, glass wares and other equipments.

The Director of Instruction (Vety.) requested the Director of Extension and Director of Research and other officers of the UAS to visit the Veterinary College and meet the staff directly for solving the problems.

The Director of Instruction (Fisheries) requested for decentralisation of accounts, especially by posting of Accounts Officer for Mangalore and other Regional Research Stations. He also stressed the need for establishing an Instrumentation cell at each of the R.R.S.

The Director of Instruction (PGS) requested for decentralisation of accounts to provide reserve amount to the tune of Rs. 1,00,000 for petty civil works at the disposal of the DIs. He appealed for increasing the farm resources by way of increasing the crop production by using the improved recommended farm management practices. He requested for strict security arrangement to overcome the thefts that are occuring at the research stations. He stated that the vehicles provided to the Research Stations have become too old and they should be

replaced with new ones. He emphasised the need for taking the best advantage of the PG students to solve the important problems in association with the scientists working in various disciplines.

The Director of Instruction (BHS) requested for proper maintenance of water supply, electricity and drainage system, to the University laboratories and buildings. There should be separate budget for equipment. He appealed that the scientists working in the different basic sciences should also be involved in research work of the University.

The Director of Instruction (Agri), Hebbal expressed his satisfaction over the cooperation of the officers at Hebbal. He requested for proper accounting of the purchases made during the financial year, and for early filling up of the vacant posts in the teaching sections.

The Director of Instruction (Agri), Dharwad, said that the University structure is well thought of and is working well. But speed is sacrificed everywhere. He requested for speedy delivery of the letters and this requires streamlining and strengthening of the despatch sections. He felt that there is necessity to have seminars and research programmes on different crops about the recent technology. He also requested for strengthening of basic sciences Departments like Basic Chemistry, Biochemistry, Mathematics and Statistics. He stated that the research staff are overburdened with the teaching work and suggested the need for creating some more supporting staff to the teaching Departments especially when the Extension Department has heavy programme of T & V, Lab-to-land and the training of KSDA officials. He also, emphasised the need for strengthening the financial position of the Departments when they are involved in the above programmes.

The Vice-Chancellor while summing up said that the object of convening this research management seminar was to invite the attention of all the scientists as to their research responsibility and technical competence for further improvement in their

field so that they can all work as a team in the University. He also appreciated the highlights and shortcomings in the research systems as brought out by the several Directors and the papers presented the research responsibilities. He felt that there is a need for such meetings to be had more than once a year to review the progress made by them and plan for the future. He expressed that under the existing conditions, decentralisation of financial unit is not possible, especially under the present statutory rules. However, he assured speedy action on sanctions, passing of bills, payment and the like. With regard to the filling up of the vacancies, he appealed to bear with him for some more time. He stated that the University is contemplating, institution of a security enforcement force. He felt that there is a scope for making good improvement in the Store Purchase Department and also the despatch section. He assured to plough back the profits of different research stations. He asked the University officials to be alert since the University also comes under the purview of the Vigilence Commission of the Karnataka State. He thanked once again all the scientists for their active participation in the Seminar.

Director of Research proposed vote of thanks to Vice-Chancellor, all the officers and the scientists who attended the meeting including all those who helped in conducting the seminar and making it successful.

Summary of Recommendations

1. UAS Research projects which have gone on for more than three years by the end of 1979 have been deemed concluded (copies of the Directory given to all the participants and also sent to Heads of Departments). The Heads of Departments, should arrange to send the conclusion reports for these projects concerning to them. Scientists may submit new project proposals to meet the present requirements, to be operated either from UAS funds or outside agencies, following the procedure already prescribed.

   The conclusion reports may be got printed in a systematic way faculty-wise. (Action : All Heads of Departments/DR).

2. The Research project numbering system with the correct DR No. assigned to each project/experiment should be strictly followed (Papers circulated to all the participants and also sent to Heads of Departments). The experiments conducted without the approval of the D. R. and proper D. R. No., will be considered as unauthorised research work. There should be orientation towards research based on regional problems.

   (Action : All Heads of Departments/All University Co-ordinators of AICRPs and Principal Investigator of outside funded projects/Project leaders of UAS funded projects/All Chief Scientific Officers/All Farm Superintendents/All Research Assistants in-charge of the Stations).

3. Chief Scientific Officer's are responsible for sending the Technical Programme of the whole stations, cropping plan, Station bulletin, Annual Station report etc., of the Stations coming under their jurisdiction regularly. The concerned

Farm Superintendent/Research Assistants incharge of Stations should see that this is attended to, promptly on time. Like-wise, all Heads of Departments should send the Technical Programme for their Department in the University.

(Action : All Chief Scientific Officers/Farm Superintendents/ All Research Assistants incharge of Stations and Heads of Dept.)

4. It is observed that in many of the Research Stations receipts do not commensurate with the contingent expenditure. Whenever the returns are not reasonably proportional to the investment, the responsibility will be fixed on the concerned Chief Scientific Officers/Farm Superintendents/Research Assistants.

(Action : All C.S.Os/All Farm Superintendents/All Research Assistants incharge of Stations).

5. The experimental produce register should be maintained as already prescribed in all the Research Stations/Schemes/ Departments and the produce strictly accounted for. (Action : All Heads of Departments/All University Co-ordinators/Principal Investigators/Project Leaders/All CSOs/ All Farm Superintendents/All Research Assistants). Separate accounts should be maintained for all the experiments conducted and should follow proper accounting and budgeting. Amount budgeted should be allocated/distributed over the full year).

6. In some of the Co-ordinated Research programmes, there is lack of Inter-disciplinary approach. This would defeat the very purpose of Co-ordinated approach, among the desciplines concerned. The University Co-ordinators, should see that such an approach is not lacking and every effort is made for the successful functioning of the Research Projects.

(Action: All University Co-ordinators of AICRP's and All Principal Investigators of outside funded projects).

7. It is also seen in some of the Co-ordinated research projects of ICAR, there is lack of Co-ordination among the University Co-ordinator of the project, the research personnel of the project and the Heads of Departments concerned. The University Co-ordinators of the project should co-ordinate all the personnel working in the project. He is solely responsible for smooth functioning of the project. The Heads of Departments concerned should cooperate to the best of their ability by only extending their technical expertise, in respect of the research projects, wherever scientists belonging to their concerned departments are involved. The administrative matter rests with the concerned project co-ordinator. The Project Co-ordinator, the concerned research personnel and the concerned Heads of the Departments should work with an integrated approach to the research problem.

(Action: All University Co-ordinators/All the Research personnel of the Co-ordinated Projects/All the Heads of Dept.)

8. Certain difficulties, mostly of the administrative type are faced by the University Co-ordinators in some of the research projects manned by the scientists of the same rank. Hence, the Co-ordinator should work out in detail job chart for each person working in the project (including Ministerial staff) so that no problem is faced. They should resolve problems in periodical meeting with all the concerned scientists.

(Action: All University Co-ordinators of AICRP's and Principal Investigators of projects funded by outside Agencies).

9. It is seen, in some of the co-ordinated and other research projects, the research staff are assigned teaching work at

the cost of the legitimate work of the research project. This should never happen and any type of an action leading to hampering of the project work, should be discouraged. (Action: All Heads of Dept./All University Co-ordinators).

10. In some of the research stations, adequate facilities such as, laboratory, quarters, irrigation, land, watch and ward, fencing etc., are lacking to carry out the work satisfactorily. This affects the research work adversely. Every effort should be made to provide required facilities. Services and supplies should be extended to all concerned on priority basis and should be attended to promptly. Immediate action is needed to effectively make use of Hebbal tank and its irrigation facility.
(Action : Estate Officer).

11. There are instances of incurring expenditure out of the project funds, by the drawing officers other than the Heads of projects, without the knowledge of the project heads which is highly irregular and should never be repeated. Any expenditure should be effected with the full written concurrence of the project Head. (Action: All Drawing Officers, Co-ordinators, Principal Investigators).

12. For good research work, there should be a good administrative set up and all the sanctioned posts must be filled up. All the staff must be in their positions. There should be no delay in the movement of papers and prompt action should be taken at the appropriate time. There should be no gap in communication. All efforts may be putforth for proper co-ordination to exist. The despatch section should be well organised and work very efficiently. Scientists should not move about tracking their papers. (Action : Administrative Officer).

13. There should be a central place to pool all the instruments/ equipments used by different Departments/Schemes/Research Stations of the University, so that all concerned can use them in one place. Also, persons working in the units, not

having the instruments, who are in actual need can also derive the benefit. Log books of equipments etc., must be maintained. (Action : Estate Officer/All Scientists).

14. Transfer of the staff, both technical and ministerial, working in the projects without the knowledge of the Heads of the projects, affects the work adversely. This should be avoided. (Action : Administrative Officer/DR).

15. Fundamental research by the teachers should be done on priority basis. Research suggested by the Department of Agriculture, Horticulture, Animal Husbandry and Fisheries should be taken up promptly. Research of immediate relevance to farming community, research on regular basis, should be selected. (Action : Heads of Departments).

16. There is a tendency among the research workers to concentrate their work at Hebbal/GKVK/Dharwad. This should be fully discouraged. Various research projects should be spread over to other research stations. (Action : All Heads of Departments/All Chief Scientific Officers/D.R.)

17. The concept of integration of teaching, research and extension at the scientist level has to be re-examined in the light of present developments. There is also need for decentralisation of technical, administrative and financial powers in the hierarchy of scientific staff and preparation of job charts. (Action : Directors of Instruction/D.R./ D.E.).

18. There is a great need to conduct seminars on various crops, highlighting the latest findings and pointing out the gaps in research, so that decision could be taken regarding the future line of work. This may be planned early. University Scientists should initiate research on crops not covered in Co-ordinated Research Projects. (Action : All Heads of Departments/all University Co-ordinators).

19. There is a great need for the scientists to be trained in the management of Research (Action : D.R.).

20. In view of the problems faced by the Head of the Department of Agril. Engineering, Dharwad, regarding the repairs to be undertaken to the farm and other machineries, etc. there is need for setting up of a workshop, Tractors and other machineries under the control of the Farm Superintendent may be transferred to the Agril. Engineering Dept. for a better technical management. (Action: Head of the Dept. of Agril. Engineering, Dharwad).

21. There is need for the establishment of a composite livestock farm, to take up research work in the field of animal production. Also, there is need for an experimental house, to take up research programme on animal health. Establishment of Departments like (1) Department of Meat Science and Technology and (2) Department of Toxicology are also necessary. (Action: Director of Instruction (Vety.)/D.R.).

22. There is need for the drawing powers to be given to the Head of the project, in view of the problems involved in the maintenance of animals, feed, watch and ward, lab. equipment etc. (Action: Comptroller, Director of Instruction (Vety), Director of Instruction (Fisheries) and Director of Instruction (H.Sc).

23. Procedure for the publication of research results needs to be streamlined. (Action: Editor, Communication Council).

24. All scientists should maintain better integrity of research. There should be personal approach for solving the problems and dedication to the work. There should be efficient management of human relations and skills for the efficient management of research. As such, there is a great need for effective attitudal changes. Working of the Co-ordinated projects should be studied, so as to bring to light the real reasons for the present problems in the execution. (Action: Professor Chandrasekhara Buggi).

LIST OF PARTICIPANTS

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115. Mr. T. K. Siddarame Gowda, Microbiologist, ARS, Gulbarga.

116. Mr. Giriraj, Senior Sunflower Breeder, Super Elite and Elite Sunflower Scheme, GKVK, Bangalore.

117. Mr. D. Rangamannar, Farm Technical Officer, DR's Office, GKVK, Bangalore.

ERRATA

Title : Procedure for the preparation and submission of project proposals for UAS and outside agencies for funding, by K. Krishna Murthy and R. Vijayamma.

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Approved Projects

After the project is approved D.R. Code number is assigned for each approved Research project. All the experiments taken up under an approved Research project should be serially numbered and the experiment number will be expressed as a decimal of D. R. Code number. If any new experiment is added at any time, then it will have a continuation serial number. The D.R. Code number should invariably be quoted in all the proforma and correspondence connected therewith. Each department should have Directory of research projects and experiments and that to all concerned.